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Instruction Manual

CTEC CALIBRATION CENTER

MODEL

1920A

TELECOMMUNICATION COUNTER

FLUKE®

JOHN FLUKE MFG. CO. LTD.
Scarborough, Ontario.
Buffalo, New York.

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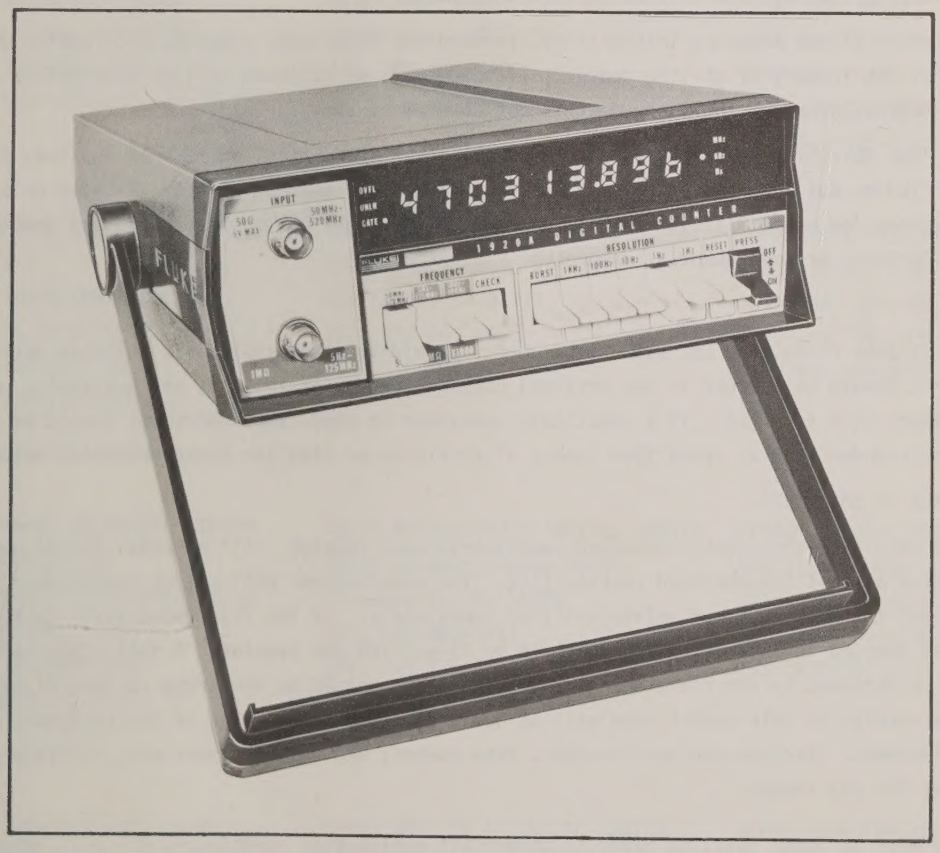
JOHN FLUKE MFG. CO. LTD.

2247 MIDLAND AVENUE
SCARBOROUGH, ONTARIO
M1P 4R1

P.O. BOX 1094
STATION D
BUFFALO, N.Y.
14210



MODEL

1920A

TELECOMMUNICATION COUNTER

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*For European customers FLUKE (Nederland) B.V.
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Tilburg, Netherlands

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FLUKE TECHNICAL SERVICE CENTERS

FLUKE WESTERN TECHNICAL CENTER
2020 North Lincoln Street
Burbank, CA 91504
Tel. 213-849-7181
TWX: 910-498-2249

FLUKE MIDWESTERN TECHNICAL CENTER
1287 North Rand Road
Des Plaines, IL 60016
Tel. 312-298-7470
TWX: 910-233-4978

FLUKE EASTERN TECHNICAL CENTER
4515 Culver Road
Rochester, NY 14622
Tel. 716-342-6940
TWX: 510-253-6145

FLUKE WESTERN TECHNICAL CENTER
2359 De La Cruz Blvd.
Santa Clara, CA 95050
Tel. 408-244-1505
TWX: 910-338-0121

FLUKE MIDEASTERN TECHNICAL CENTER
11501 Huff Court
Kensington, MD 20795
Tel. 301-881-5300
TWX: 710-825-9645

FLUKE S.E. TECHNICAL CENTER
P. O. Box 9619
1310 Beaman Place
Greensboro, NC 27408
Tel. 919-273-1918
TWX: 510-925-1173

FLUKE S.W. TECHNICAL CENTER
Unit # 4
1980 South Quebec Street
Denver, CO 80231
Tel. 303-750-1228
TWX: 910-931-2685

FLUKE N.E. TECHNICAL CENTER
109 Massachusetts Avenue
Lexington, MA 02173
Tel. 617-861-8620
TWX: 710-826-1715

JOHN FLUKE MFG. CO. INC.
7001 - 220th S.W.
Mountlake Terrace, WA 98043
Tel. 206-774-2238
TWX: 910-449-2850

FLUKE S.E. TECHNICAL CENTER
P. O. Box 6578
940 North Fern Creek Avenue
Orlando, FL 32803
Tel. 305-896-2296
TWX: 810-850-0185

FLUKE MIDWESTERN TECHNICAL CENTER
10800 Lyndale Avenue South
Minneapolis, MN 55420
Tel. 612-884-4541
TWX: 910-576-3141

FLUKE CANADIAN TECHNICAL CENTER
640 11th Avenue S.W.
Calgary Alberta
Tel. 403-261-0780
TWX: 610-821-2233

FLUKE INTERNATIONAL CORP.
Garnett Close
Watford, WD2 4TT
England

FLUKE EASTERN TECHNICAL CENTER
500 Union Blvd.
Totowa, New Jersey 07512
Tel. 201-742-3215
TWX: 710-988-5949

FLUKE CANADIAN TECHNICAL CENTER
6427 Northam Drive
Mississauga, Ontario
Tel. 416-678-1500
TWX: 610-492-2119

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Section 1

Introduction & Specifications

1-1 INTRODUCTION

1-2 The Fluke Model 1920A Digital Counter is a 5 Hz to 520 MHz (to 1 GHz or 1.25 GHz, optional) counter designed primarily for telecommunications applications. The unit is compact and lightweight making it fully portable and suitable for field use. An optional battery-operated version of the counter permits use at remote or mobile installations where AC line power is unavailable.

1-3 The display is nine digits, light-emitting-diode type (LED) with leading-zero suppression and automatic decimal point positioning. Display resolution is front-panel selectable at 1 KHz, 100 Hz, 10 Hz, 1 Hz or 0.1 Hz. Annunciators are provided to indicate the measurement unit (i.e. MHz, KHz, or Hz) and also overflow when the capacity of the display is exceeded. All displayed measurement data is also available in a CMOS-compatible, parallel BCD output at a rear-panel connector when the unit is equipped with an optional Data Output Unit (DOU, Option-02).

1-4 Input sensitivity for the 1920A is better than 15 mVrms and AGC is incorporated to provide stable operation. Extremely low-level signals which cannot be reliably measured, fall below the AGC threshold and are ignored by the counting circuitry. A "burst" mode is provided to permit the measurement of keyed RF signals having a duration of two milliseconds or greater. The display is automatically held at zero if the RF burst is of shorter duration than the selected gate time (resolution).

1-5 The 1920A also incorporates an optional high-resolution mode (Option-06) to permit the measurement of low frequency signals, such as signalling tones, while using conveniently short gate times. In this mode, input signals in the range of 10 Hz to 10 kHz are multiplied by a factor of 1000 allowing the use of shorter gate times for better resolution. A self-check mode of operation is also provided to verify proper overall performance of the digital circuitry and the display of the unit prior to use.

1-6 Power requirements for the 1920A are 100, 115 or 230 Volts at 50 to 400 Hz for the line-powered version. Model 1920A-01, is equipped with rechargeable nickel-cadmium batteries which provide a minimum of three hours of operation. The battery-powered unit also operates from the AC power line, and at the same voltages as the line-powered instrument.

1-7 The standard time base TCXO has an aging rate of $\pm 3 \times 10^{-7}$/month and $\pm 2 \times 10^{-6}$, 0°C to 50°C. An optional TCXO (Option-04) provides an aging rate of $\pm 3 \times 10^{-7}$/month and $\pm 5 \times 10^{-7}$,

0°C to 50°C. In addition, an external time base signal of 1 MHz, 5 MHz or 10 MHz may be connected via a rear-panel BNC connector.

1-8 SPECIFICATIONS

1-9 The pertinent specifications for the Model 1920A are listed in the following Table, 1-1. Physical dimensions of the unit are shown in Figure 1-1.

TABLE 1-1 1920A SPECIFICATIONS

FUNCTIONS	
DIRECT PREAMPLIFIER	
Frequency Range:	5 Hz to 125 MHz with AGC
Input Impedance:	1 M ohm with 30 pF max.
Sensitivity:	15 mV rms up to 100 MHz decreasing to 25 mV rms at 125 MHz
Overload:	150 V rms up to 1 kHz decreasing to 5 V rms at 125 MHz
Gate Times:	1 ms, 10 ms, 0.1 s, 1 s, 10 s
Accuracy:	± (1 count + timebase accuracy)
PRESCALED AMPLIFIER	
Frequency Range:	50 MHz to 520 MHz with AGC 50 MHz to 1000 MHz (option-13) 50 MHz to 1250 MHz (option-14)
Input Impedance:	50 ohm, VSWR 2.5:1 max. @1 V rms input level
Sensitivity:	15 mV rms to 520 and 1000 MHz decreasing to 30 mV rms at 1250 MHz.
Overload:	5 V rms, fuse protected
Gate Times:	4 ms, 40 ms, .4 s, 4 s, 40 s, 8 ms, 80 ms, .8 s, 8 s, 80 s, (1000 and 1250 MHz)
Accuracy:	± (1 count + timebase accuracy)
RESOLUTION MULTIPLIER (OPTION-06)	
Frequency Range:	10 Hz to 10 kHz
Lock-up Time:	1.5 seconds max.
Gate Times:	1 ms, 10 ms, .1 s, 1 s, 10 s
Accuracy:	± (2 counts + timebase accuracy)
SELF CHECK	The Reference Oscillator is internally connected to the digital logic input. Pressing RESET automatically lights all segments of each display digit.

TABLE 1-1 1920A SPECIFICATIONS (continued)

TIMEBASE

	STANDARD	-04 OPTION
Frequency	10.00 MHz	10.00 MHz
Aging Rate	$< \pm 3 \times 10^{-7}$/month	$< \pm 3 \times 10^{-7}$/month
Temperature Stability 0 - 50°C	$< \pm 2 \times 10^{-6}$	$< \pm 5 \times 10^{-7}$
20 - 30°C	$\pm 5 \times 10^{-7}$ typ.	$\pm 2 \times 10^{-7}$ typ.
Line Voltage (±10% change)	$< \pm 1 \times 10^{-7}$	$< \pm 5 \times 10^{-8}$

EXTERNAL TIMEBASE INPUT

Frequency Required:	1 MHz, 5 MHz or 10 MHz
Sensitivity:	100 mV rms
Impedance:	2 k ohms, 40 pF; 1 k ohms above 500 mV rms
Overload:	20 V rms

OUTPUTS (Option-02)

Provides parallel BCD CMOS compatible outputs from each digit plus overflow, units annunciation, decimal point and print command.

ENVIRONMENTAL

Temperature Range:	0° to +50°C (operating)
	0° to +40°C (during charging with option-01)
	-40° to+60°C (storage)
Altitude:	10,000 ft. (operating)
	40,000 ft. (non-operating)

GENERAL

Charge Time (option-06):	14 hours (not operating)
	56 hours (operating)
Discharge Time (option-06):	3 hours min.
Power Requirements	50 - 400 Mz; 115/230 V ±10%, (100 V ± 10% optional) 15 Watts typical
Weight (approx.):	6 lbs. 2.7 kg.
Weight with batteries (approx.):	8 lbs. 3.6 kg.

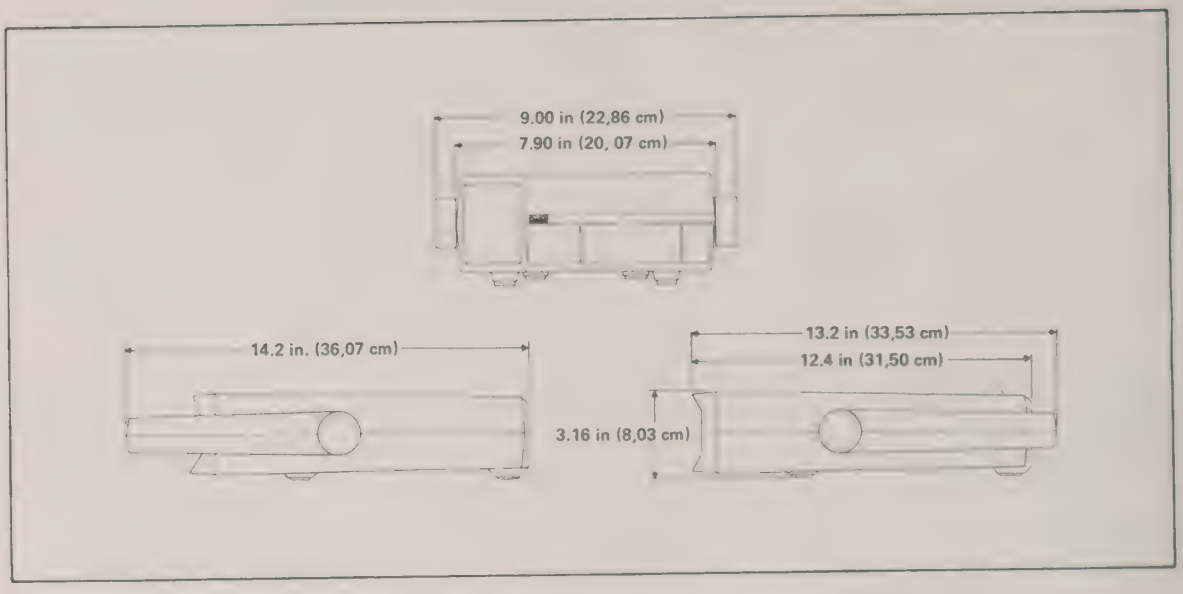

Figure 1-1 MODEL 1920A OUTLINE DRAWING

Section 2

Operating Instructions

2-1 INTRODUCTION

2-2 This section contains operating information for the Model 1920A. The contents of this section should be read before operating the counter. Should any difficulties arise during operation of this instrument, please contact your nearest John Fluke Sales Representative, the John Fluke Mfg. Co. Ltd., 2247 Midland Avenue, Scarborough, Ontario, M1P 4R1 or P. O. Box 1094, Station D, Buffalo, New York 14210. A list of Sales Representatives is located at the rear of this manual.

2-3 SHIPPING INFORMATION

2-4 The model 1920A is packaged and shipped in a protective container. Upon receipt of the equipment, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included in the shipping carton.

2-5 If reshipment of the equipment is necessary, the original container should be used. If the original container is not available a new container can be obtained from the John Fluke Mfg. Co. Please reference the equipment model number when requesting a new shipping container.

2-6 INPUT POWER

2-7 Both the line-powered and battery-powered versions of the Model 1920A can operate from either a 115 V or 230 V AC power line. Before connecting to the power line, ensure that the line power selection switch is in the position which corresponds to the power line voltage. To gain access to the switch, loosen the two retaining screws (located on the rear of the case) and remove the unit from the case. The power line selection switch is located in the right rear corner of the main printed circuit board assembly in proximity to the power switch. (On the 100 VAC version of the 1920A, no power line selection switch is provided since 100 Volts is the only suitable AC source).

2-8 RACK INSTALLATION

2-9 The Model 1920A may be center-mounted in a standard 19-inch rack when supplied with the appropriate rack mounting kit. Instructions for installing units in the rack mount are supplied with the rack mounting kit. The center rack mounting kit is Model No. M00-200-625.

2-10 POWER FUSE

2-11 Power supply protection is provided by means of a line fuse having a rating of 0.25 Amperes, MDL type, slow-blow. To gain access to the line fuse, loosen the two retaining screws (located on the rear of the case) and remove the unit from the case. The line fuse is located in the right, rear corner of the main PCB assembly.

2-12 HANDLE ADJUSTMENT

2-13 The handle tension may be adjusted through the holes in the two handle decals using a Phillips screw driver.

2-14 CONTROLS, INDICATORS AND CONNECTORS

2-15 The location and function of all controls, indicators and connectors are shown in Figure 2-1 and described in Table 2-1.

TABLE 2-1 CONTROLS AND INDICATORS

Item No.	NAME	FUNCTION
1	5 Hz - 125 MHz 1 M BNC connector	Provides connection to the direct (non-prescaled) input of the counter for signals in the range of 5 Hz to 125 MHz.
2	50 MHz - 520 MHz 50 BNC connector (50 MHz-1 GHz or 1.25 GHz Optional)	Provides connection to the prescaled input of the counter for signals in the range of 50 MHz to 520 MHz on the standard unit (50 MHz to 1 GHz and 50 MHz to 1.25 GHz are available with Options -13 and -14 respectively).
3	Gate Lamp	Lights to indicate a measurement is being made.
4	UNLK Lamp (Option -06)	Part of Option-06, Lights when the x1000 frequency multiplier (high resolution) function is selected and the frequency multiplier has not yet achieved phase lock-up, giving an ambiguous display.
5	OVFL Lamp	Lights to indicate that the display capacity has been exceeded due to selection of fine resolution (long gate time).
6	Display LED's	Display consists of nine digits. Leading zeros are suppressed.
7	Hz Lamp	Lights to indicate display is reading Hz.
8	kHz Lamp	Lights to indicate display is reading kHz.
9	MHz Lamp	Lights to indicate display is reading MHz.
10	POWER Switch	A push-push switch to energize the counter.

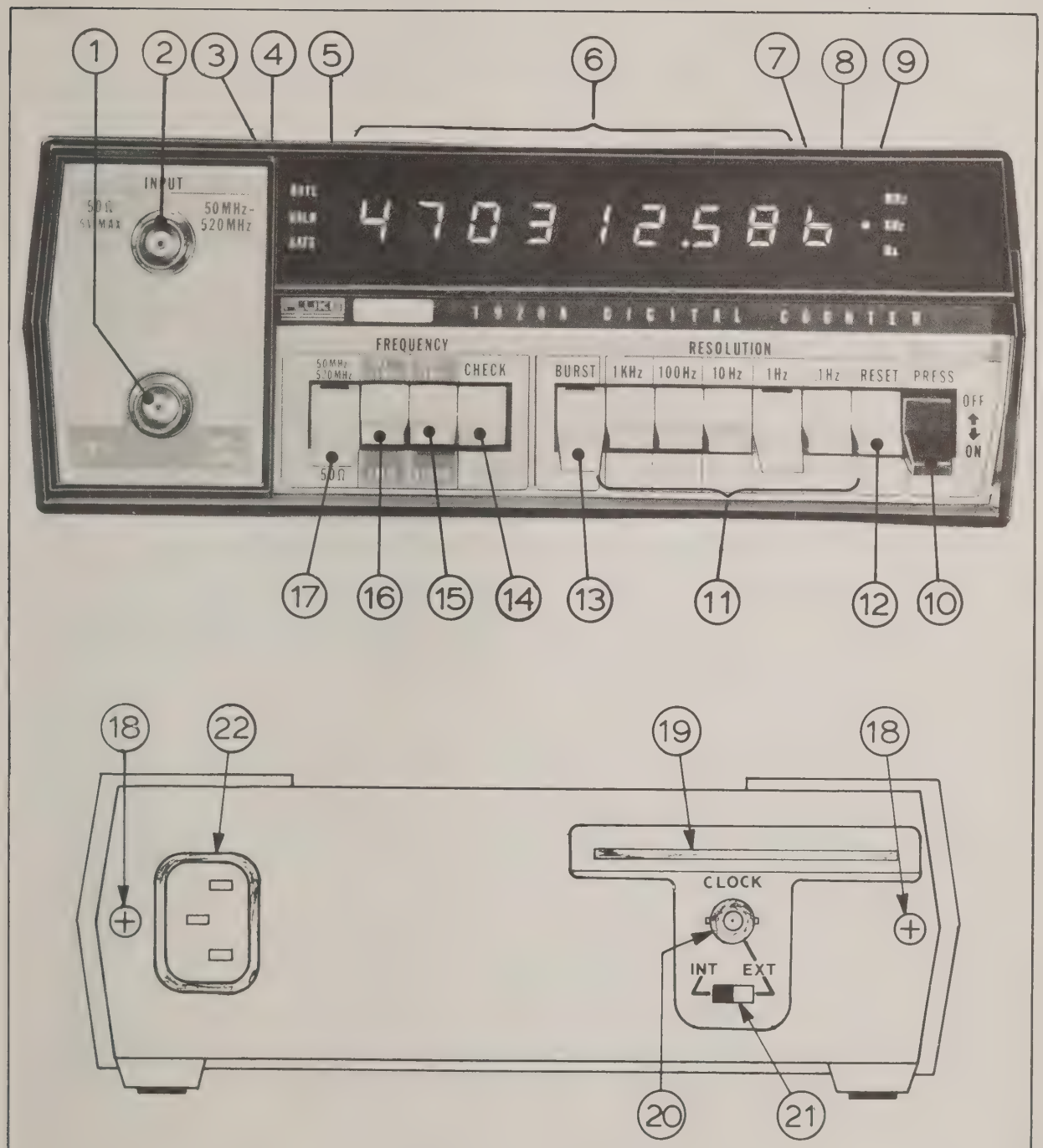

Figure 2-1 Controls, Indicators and Connectors

TABLE 2-1 CONTROLS AND INDICATORS (continued)

11	RESOLUTION Switches	A series of five switches to select the desired measurement resolution. For example, if 10 Hz Resolution is selected, the least significant digit represents 10 Hz.
12	RESET Switch	A push-button switch when pressed resets the counter to zero and initiates another measurement. When pressed with CHECK function selected, causes all correctly operating display segments to illuminate.
13	BURST Switch	A push-button switch to select the Burst mode of operation which measures keyed RF bursts.
14	CHECK Switch	A push-button switch to select the Self-Check mode of operation.
15	10 Hz-10 kHz, x1000 switch (Option-06)	Installed for Option-06 only, a push button switch to select the high-resolution mode of operation.
16	5 Hz-125 MHz 1 MΩ switch	A push-button switch to select the direct (non-prescaled) input for measurement of signals in the range of 5 Hz to 125 MHz.
17	50 MHz - 520 MHz 50Ω Switch (50 MHz-1 GHz or 50 MHz - 1.25 GHz)	A push-button switch to select the prescaled input for measurement of signals in the range of 50 MHz to 520 MHz (50 MHz to 1 GHz, Option-13 or 1.25 GHz, Option-14).
18	Retaining Screw	Philips-head screw attaching case to instrument chassis.
19	DOU Connector (Option-02)	A 50-pin PCB connector which accesses measurement data when the Data Output Unit, Option-02, is installed.
20	CLOCK Connector	Provides for connection of an external timebase signal of 1 MHz, 5 MHz or 10 MHz (depending on internal jumper configuration) when the INT/EXT switch (see item 21) is placed in the EXT position.
21	INT/EXT Switch	Slide switch to select either the internal timebase or an external timebase signal applied to the CLOCK Connector.
22	Power Connector	Provides connection through line cord to AC power line.

2-16 SELF-CHECK MODE

NOTE: - The following procedure assumes a 10 MHz timebase. Substitute appropriate readings if a 1 MHz or 5 MHz external timebase is being used.

2-17 The self-check mode provides a means of verifying proper overall operation of the counter, excluding the direct input amplifier, the prescaled input amplifier and the high resolution multiplier. To self-check the unit, proceed as follows:

a. Press the Power switch to the ON position.

b. Press the CHECK switch.

c. Press the RESET switch. All display segments should light. The display should read 888888888.

d. Press the 1 kHz RESOLUTION switch. The display should read 10.000 Mhz ± 1 digit.

e. Press the 100 Hz RESOLUTION switch. The display should read 10.0000 MHz ± 1 digit.

f. Press the 10 Hz RESOLUTION switch. The display should read 10000.00 kHz ± 1 digit.

g. Press the 1 Hz RESOLUTION switch. The display should read 10000.000 kHz ± 1 digit.

h. Press the 0.1 Hz RESOLUTION switch. The display should read 10000.0000 kHz ± 1 digit.

2-18 FREQUENCY MEASUREMENTS

2-19 INPUT CONNECTIONS

2-20 Signals to be measured by the Model 1920A are applied to either one of two BNC input connectors mounted on the left side of the front panel. The direct input (lower connector) accepts signals in the range of 5 Hz to 125 MHz. The prescaled input (upper connector) accepts signals in the range of 50 MHz to 520 MHz (to 1 GHz with Option-13, or to 1.25 GHz with Option-14). The input impedance of the direct input is 1 Megohm shunted by less than 30 pF, while the prescaled input is 50 ohms.

2-21 5 Hz to 125 MHz, DIRECT MODE (Colour Coded Blue)

2-22 The 5 Hz to 125 MHz input is used in the direct measurement mode. This input is protected from overload to withstand inputs as high as 150 Volts rms at frequencies below 1 kHz without damage. Overload capability decreases from 150 Volts rms at 1 kHz to 5 Volts rms at 125 MHz.

2-23 To make frequency measurements in the direct mode, proceed as follows:

a. Connect the input signal to the lower front panel BNC connector.

b. Press the 5 Hz - 125 MHz switch.

c. Select the desired resolution, read the measurements on the display and note the

unit of measurement (i.e. MHz or kHz).

2-24 50 MHz to 520 MHz (1 GHz and 1.25 GHz) PRESCALED MODE (Colour Coded Yellow)

2-25 The 50 MHz to 520 MHz (1 GHz, or 1.25 GHz) input is used in the prescaled measurement mode. This input is protected from overload to withstand inputs as high as five Volts rms without damage. (Overload protection is provided by a PCB mounted 2/10A fuse).

2-26 To make frequency measurements in the prescaled mode, proceed as follows:

a. Connect the input signal to the upper front panel BNC connector.

b. Press the 50 MHz to 520 MHz (1 GHz or 1.25 GHz) switch.

c. Select the desired resolution, read the measurement on the display and note the unit of measurement (i.e. MHz or kHz).

2-27 HIGH RESOLUTION MODE, OPTION-06 (Colour Coded Blue)

2-28 In order to make conveniently rapid measurement of low frequency signals, a high-resolution mode of operation is available which shortens the internal gate times and speeds-up measurement cycles. For example, a low frequency tone being measured with a resolution of 0.1 Hz would normally require a gate time of ten seconds. To adjust the frequency of the tone while observing the counter would be extremely difficult due to the time lag between the adjustment and the resultant display on the counter. The high resolution mode eliminates the problem by multiplying the input signal by a factor of 1000, which allows a shorter gate time to be selected. In this mode, 0.1 Hz resolution is obtained by pressing the 100 Hz switch to select a gate time of 10 milliseconds instead of ten seconds.

The RESOLUTION switches each select resolutions which are finer by a factor of 10^{-3} due to the multiplication of the input by 10^{3} for a given gate time. That is, 1 kHz resolution becomes 1 Hz resolution, 100 Hz becomes 0.1 Hz, etc.

2-29 To make measurements in the high resolution mode, proceed as follows:

a. Connect the 10 Hz to 10 kHz input signal to the lower front panel BNC connector.

b. Press the 10 Hz to 10 kHz X1000 switch.

c. Select the desired resolution. Note that the resolution is increased by a factor of 10^{3} so that selection of 1 Hz resolution is actually 0.001 Hz resolution, 10 Hz is actually 0.01 Hz, etc.

d. Read the measurement on the display and note the unit of measurement (i.e. kHz or Hz).

NOTE

If the UNLK lamp lights or flashes while the display reads zero, the upper (10 kHz) or lower (10 Hz) frequency limit of the input multiplier has probably been exceeded.

2-30 The High Resolution Mode Option may be ordered by part number 1920A-06. The option must be installed at the factory at the time of purchase.

2-31 BURST MODE

2-32. The function of the burst mode is to measure the frequency of keyed RF signals having a duration of one millisecond (shortest gate time) or longer. RF bursts must be longer than the gate time selected in order to achieve an accurate measurement.

2-33 To make measurements of keyed RF bursts, proceed as follows:

a. Connect the input signal to the appropriate front panel BNC connector (i.e. direct or prescaled input) and press the corresponding FREQUENCY selection switch.

b. Press the BURST switch.

c. Select the desired resolution and read the measurement on the display. If the display reads zero, yet the GATE lamp flashes (indicating that bursts are present and measurements are being attempted), the Burst input is of shorter duration than the gate and a shorter gate time must be selected.

2-34 EXTERNAL TIME BASE (REFERENCE CLOCK)

2-35 The Model 1920A permits the use of an external time base in substitution for the internal time base. The external time base may be 1, 5 or 10 MHz, in the range of 100 mVrms to 20 Vrms. Input impedance is 2,000 ohms (1000 ohms after clipping for signals above 500 mVrms). Connection is made via the rear panel BNC connector and the INT/EXT slide switch is placed in the EXT position. It may be necessary to make a jumper modification on the main PCB assembly in order to accommodate the particular external reference frequency being used. For instance, the Model 1920A is factory-jumpered for a 10 MHz external reference signal, and must be modified if a 1 MHz or 5 MHz signal is to be used.

2-36 To modify the main PCB assembly for the application of a 1 MHz or 5 MHz external reference signal, proceed as follows:

a. Remove the unit from the case by loosening the two retaining screws on the rear of the case.

b. Locate the reference jumper pads on the main PCB, shown in Figure 5-5. (If so equipped, remove the DOU PCB assembly or the Battery PCB assembly and swing away to the side).

c. Using a suitable cutting tool, such as an X-acto, Inc. knife, sever the conductive land between the REF and 10 pads.

d. Using a piece of 22 AWG wire (a lead from a 1/4 watt resistor will also suffice), insert and solder a jumper between the REF pad and the 1 pad for a 1 MHz reference, or the 5 pad for a 5 MHz reference.

2-37 BATTERY POWERED OPERATION, OPTION-01

2-38 GENERAL INFORMATION

2-39 Power for the Model 1920A-01 is supplied by internal rechargeable batteries that will operate the instrument for at least three hours. The batteries should be recharged after every three hours of battery operation. Recharging is most rapidly accomplished by switching to OFF and connecting the instrument to the AC power line. In this way, the discharged batteries can be completely recharged in approximately 12 to 14 hours. The instrument can also be operated when recharging on AC power, but recharging time will be extended to approximately 56 hours.

CAUTION

Damage may result if alkaline, zinc-carbon or mercury batteries are recharged in the instrument.

NOTE

Battery manufacturers recommend that nickel-cadmium batteries should not be stored for extended periods of time without recharging at least every 90 days. Storage temperatures below 25°C are recommended.

2-40 FIELD INSTALLATION

2-41 A line-powered version of the 1920A can be equipped with Option-01 after manufacture by means of the 1920A-01K battery kit, provided the DOU option is not already installed. (If the DOU option is already installed, it can easily be removed by loosening the standoff screws on the main PCB and disconnecting the cable). To install the battery option, proceed as follows refering to Figure 5-1 sheet 3 of 4.

a. Remove the unit from the case by loosening the retaining screws at rear.

b. Locate and remove the power supply shorting plug P7 (inserted in J6 on main PCB). Insert P7 into the vacant J7 and solder.

c. Remove the two screws on the main assembly labeled in Figure 5-1 sheet 3 of 4.

d. Connect P6 on the Battery PCB to J6 on the Main PCB observing correct orientation.

e. Pull left side chassis outwards and place left side of Battery PCB into groove in left side chassis.

f. Allow right side of Battery PCB to fit into groove in right side chassis.

g. Install five screws labeled 1 and return unit into the case.

2-42 DATA OUTPUT UNIT, OPTION-02

2-43 The Data Output Unit option allows the Model 1920A to be used in a systems or data-logging environment. The DOU provides the nine digits of measurement data in BCD format and measurement unit indication at a rear-mounted 50-pin connector, plus a ready signal to transfer the data to the recording device, such as a Fluke Model 2010A Digital Printer. The DOU PCB assembly is mounted on the main PCB by means of stand-offs and is accessed through an opening in the rear of the case by means of an interconnecting cable. The option may be ordered factory installed in the 1920A at the original time of purchase of the instrument, or may be field installed by a factory authorized service center (see warranty page). Order for field installation by part number 1920A-02K.

2-44 The interconnecting cable used with the Fluke Model 2010A Digital Printer is the 2010-4416 and is available from the factory. To fabricate a cable assembly for any other application, use the 50-pin connector supplied with Option-02.

2-45 The type and length of cable used is not critical since the measurement data is static. However, loading of the signals at the recording device must be CMOS compatible. Refer to Table 2-2 for the particular pin assignments at the DOU output. The DOU output connector is numbered/lettered from A to c from left to right (as viewed from the rear) on the top side of the PCB, and from 1 to 25 from left to right on the underside of the PCB. All data is positive true CMOS compatible.

TABLE 2-2 DOU OUTPUT DATA FORMAT

PIN NO.	FUNCTION	PIN NO.	FUNCTION
A	Decimal Point 3	1	—
B	Decimal Point 1	2	Decimal Point 2
C	MHz Units	3	Ready (Print)
D	—	4	kHz Units
E	Hz Units	5	—
F	MSD-BCD 1	6	MSD-BCD 2
H	MSD-BCD 4	7	MSD-BCD 8
J	8SD-BCD 1	8	8SD-BCD 2
K	8SD-BCD 4	9	8SD-BCD 8
L	7SD-BCD 1	10	7SD-BCD 2
M	7SD-BCD 4	11	7SD-BCD 8
N	6SD-BCD 1	12	6SD-BCD 2
P	6SD-BCD 4	13	6SD-BCD 8
R	5SD-BCD 1	14	5SD-BCD 2
S	5SD-BCD 4	15	5SD-BCD 8
T	4SD-BCD 1	16	4SD-BCD 2
U	4SD-BCD 4	17	4SD-BCD 8
V	3SD-BCD 1	18	3SD-BCD 2
W	3SD-BCD 4	19	3SD-BCD 8
X	2SD-BCD 1	20	2SD-BCD 2
Y	2SD-BCD 4	21	2SD-BCD 8
Z	LSD-BCD 1	22	LSD-BCD 2
a	LSD-BCD 4	23	LSD-BCD 8
b	OVERFLOW	24	—
c	GROUND	25	—

DECIMAL POINT POSITION ON DISPLAY	DECIMAL POINT OUTPUT (PIN)		
	DECIMAL PT. 3 (PIN A) LOGIC LEVEL	DECIMAL PT. 2 (PIN 2) LOGIC LEVEL	DECIMAL PT. 1 (PIN B) LOGIC LEVEL
2SD	1	1	1
3SD	1	0	1
4SD	0	1	1

Section 3

Theory of Operation

3-1 INTRODUCTION

3-2 This section of the manual contains an overall functional description of the Model 1920A, followed by a more detailed block diagram analysis. Simplified block diagrams are included as necessary, to supplement the text.

3-3 OVERALL FUNCTIONAL DESCRIPTION

3-4 Generally, the frequency of any signal is measured by counting the number of cycles of the unknown signal for a known length of time, referred to as the gate time. Gate time is usually equal to seconds at some power of ten, i.e. one millisecond, ten milliseconds, etc. The longer the gate time, the greater the measurement resolution. The accumulated count of the input signal cycles is then fed to the display section where it is observed by the operator.

3-5 As shown in Figure 3-1, the Model 1920A comprises a direct preamplifier, an optional X1000 multiplier, a prescaler, a main gate, decade counters, a digital display, program control logic, a TCXO and timebase dividers. The unknown signal is applied to either the direct preamplifier or the prescaler input where it is limited, amplified and shaped to a squarewave for application to one input of the main gate. If the signal is applied to the prescaler, it is also divided by a factor of four (or by a factor of eight in the 1 GHz and 1.25 GHz prescalers) for application to the main gate. In the high-resolution mode, the input signal is routed through the multiplier before being applied to the main gate.

3-6 In order for the input signal to be applied to the decade counters, a main gate enable signal is required at the input of the counters. The main gate enable signal is derived from the 10 MHz output of the TCXO (or external reference) and the Timebase dividers. The 10 MHz timebase signal is applied to the range control and timebase dividers, where it is divided by a factor of 10^4, 10^5, 10^6, 10^7 or 10^8, depending upon which range (degree of resolution) is selected. If the 1 kHz resolution is selected, the TCXO output is divided by a factor of 10^4 to yield a timebase having a period of one millisecond (0.001 seconds). For a timebase of ten milliseconds, a

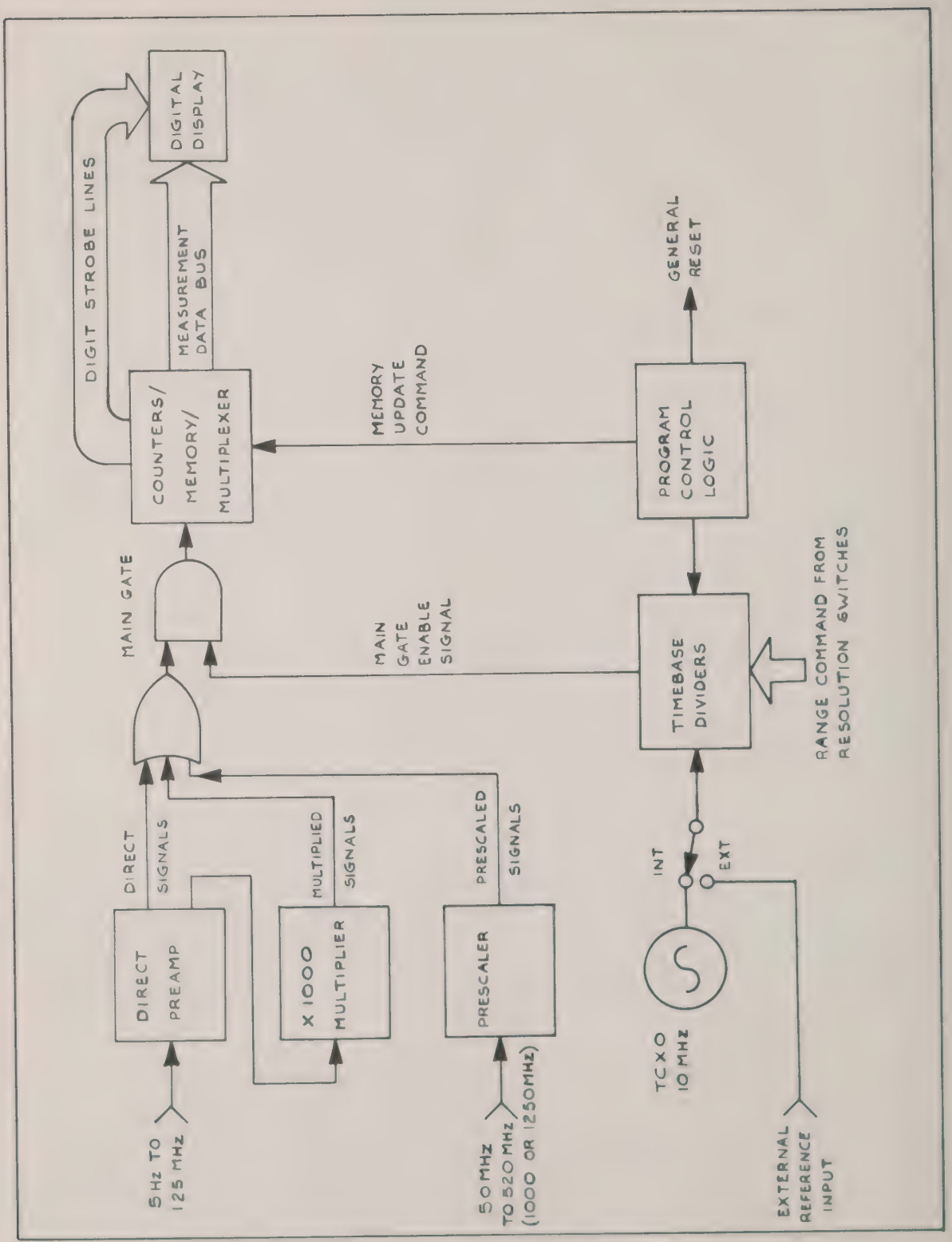

Figure 3-1 Model 1920A, Overall Block Diagram

division factor of 10^5 is used, and so on.

3-7 The above division factors apply only to the direct preamplifier mode. The prescaler mode requires additional Timebase division to achieve longer gate times since the input signal undergoes some division in the prescaler. In the 520 MHz prescaler, the additional division is by a factor of four. In the 1 GHz and 1.25 GHz prescalers, the additional division is by a factor of eight. As a result, the timebase division for the 520 MHz prescaler version of the Model 1920A is 4×10^4, 4×10^5, 4×10^6, 4×10^7 and 4×10^8. For the 1 GHz and 1.25 GHz versions, Timebase division is by factors of 8×10^4, 8×10^5, 8×10^6, 8×10^7 and 8×10^8.

3-8 The divided time base signal is applied to the main gate and enables the signal under measurement to pass through to the nine series-connected decade counters for one full period of the divided time base. The decade counters continue to accumulate the gated pulses from the input signal as long as the main gate enable signal is present. (i.e. for the period of the time base). At the end of the time base period, the main gate is inhibited and the counters no longer receive input pulses. At this time, the program control logic issues a memory update command to the display memory, causing the contents of the nine decade counters to be stored in nine memory units until the next memory update command occurs.

3-9 There are nine decade counters, nine four-bit memory units and nine display light-emitting diodes (LED's). However, the contents of only one memory unit (one digit of measurement data) is displayed on its corresponding LED at any given time. A display multiplexer sequentially places the contents of each memory unit on a measurement data bus for a period of approximately 90 microseconds. The measurement data bus is commonly connected to all digits (LED's) in the display. However, only that digit which corresponds to the memory unit being gated is enabled by means of a strobe line. As the next memory unit is gated onto the measurement data bus, the next digit is strobed to display that data. As each memory unit is gated, the corresponding LED is strobed to display the data placed on the measurement data bus, resulting in a scanning action of the display. By sequencing through the display memory and lighting each LED for only 9% of the full strobe cycle, LED power consumption is minimized. Persistence of the eye eliminates any effects of flicker.

3-10 While the last measurement is being displayed, the program control logic initiates the next measurement by generating a general reset command, to initialize various elements of the control logic. The general reset command is also used to reset the nine decade counters back to zero in preparation for the next measurement.

3-11 Operation of the 1920A in the self-check mode is similar to that described for the frequency mode except that the unknown input is replaced by the 10 MHz output of the TCXO, or a 1, 5 or 10 MHz external reference standard.

3-12 BLOCK DIAGRAM ANALYSIS

3-13 DIRECT PREAMPLIFIER

3-14 The main function of the direct preamplifier is to condition input signals prior to application to the main gate or the multiplier circuit. As shown in Figure 3-2, the 5 Hz to 125 MHz input signal is fed to a FET input buffer Q1, whose input is limited (protected by diodes CR1 and CR2.) The output of the buffer feeds the PIN attenuator diodes CR3 and CR4 and the wide band amplifier (Q2, Q3, Q4). The output of this amplifier feeds a series of three operational amplifiers (contained in a single package, U2). Each amplifier is equipped with a double ended input and output. A reference voltage line biases the first amplifier and the AGC amplifier U1-A.

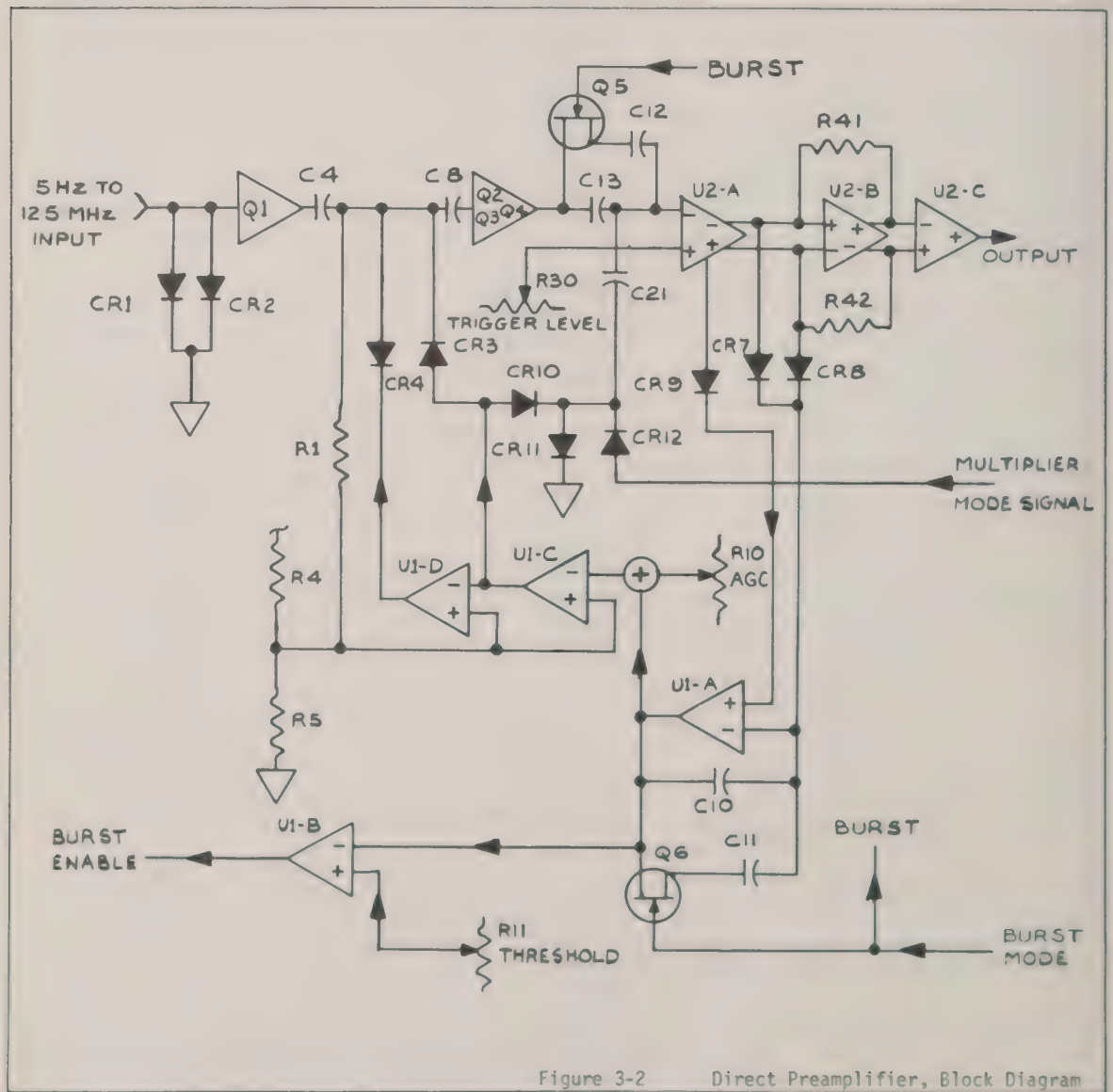

Figure 3-2 Direct Preamplifier, Block Diagram

3-15 The first amplifier of U2 operates in an open loop mode. The second amplifier is provided with positive feedback via R41 and R42. This amplifier operates as a Schmitt trigger to provide fast rise-times for low frequency inputs prior to application to the digital circuits within the counter. The input level at which the Schmitt fires is controlled by R30, the trigger level control. The third amplifier operates in an open loop mode to isolate the Schmitt trigger from excessive loading by the following ECL STAGES.

3-16 The AGC circuit receives the outputs of the first amplifier U2, which is full wave rectified by CR7 and CR8, and applied to one input of U1-A. The other input is connected to the reference voltage of U2 via CR9. The output of U1-A feeds U1-B and U1-C. U1-B operates as a switch whose trigger point is set by R11. The output of U1-B goes to the counter's control logic to signal that the signal level is acceptable and to indicate start of BURST signals in BURST mode, when that mode is selected.

3-17 The output of AGC amplifier U1-C feeds the attenuator diode CR3, while U1-D inverts the output of U1-C to feed the complimentary diode CR4 ensuring that DC offset is not introduced into the amplifier chain. The output of U1-C also feeds attenuator diode CR11 via CR10. When the counter is in RESOLUTION MULTIPLIER MODE, CR11 is also turned on to provide for low pass filtering through C21. When the counter is operated in the burst mode, the AGC response is sped up by turning Q6 off, and low Frequency cut-off is increased by turning Q9 off.

3-18 520 MHZ PRESCALER

3-19 The main function of the prescaler is to reduce the frequency of the input signal to below 130 MHz for application to the main gate and decade counters. The prescaler also provides the necessary conditioning of the input signal to provide sufficient gain and the proper waveshaping. The frequency division factor for the 520 MHz prescaler is four.

3-20 As shown in Figure 3-3, the input signal is fed through an input protection fuse, F1, to the input of the first amplifier. The output of the second amplifier is applied to the input of a divider circuit which divides by a factor of four to reduce the input frequency to below 130 MHz. The prescaled signal, amplified by U1 and U2, divided and shaped by U3, is then fed to the main PCB assembly for application to the main gate and decade counters.

3-21 The output of the second amplifier is also fed to an AGC circuit where it is rectified by CR7 and C11 and amplified by U4. The DC output of U4 is the AGC signal and controls the overall input signal level by means of CR5 and C4. Diodes CR4 and CR5 are PIN-type diodes whose impedance varies with the amount of bias applied. When the AGC signal decreases due to a reduced input signal level, the bias across CR4 is increased causing a decrease in impedance while the bias across CR5 is reduced causing an increase in impedance. This action results in a reduced shunting action of the input signal by CR5 and C4.

3-22 The AGC signal is also used to indicate the presence of an input signal to a burst enable circuit (part of the control logic) mounted on the main PCB assembly. When an input is present, the AGC line is positive to turn-on Q1 and turn-off Q4. The burst enable signal is zero

volts to the burst enable circuit and the control logic to allow normal counter operation. If the input signal is interrupted, or reduced to below minimum acceptable amplitude, Q1 and Q4 change state to provide a positive (false) burst enable signal and also clamp the prescaler output to +5 volts. (Refer also to the burst enable circuit description, Section 3-52).

N O T E

The prescaler, like the direct preamplifier, is energized only when that mode is selected. When not selected, the front panel mode switch interrupts its power supply connection.

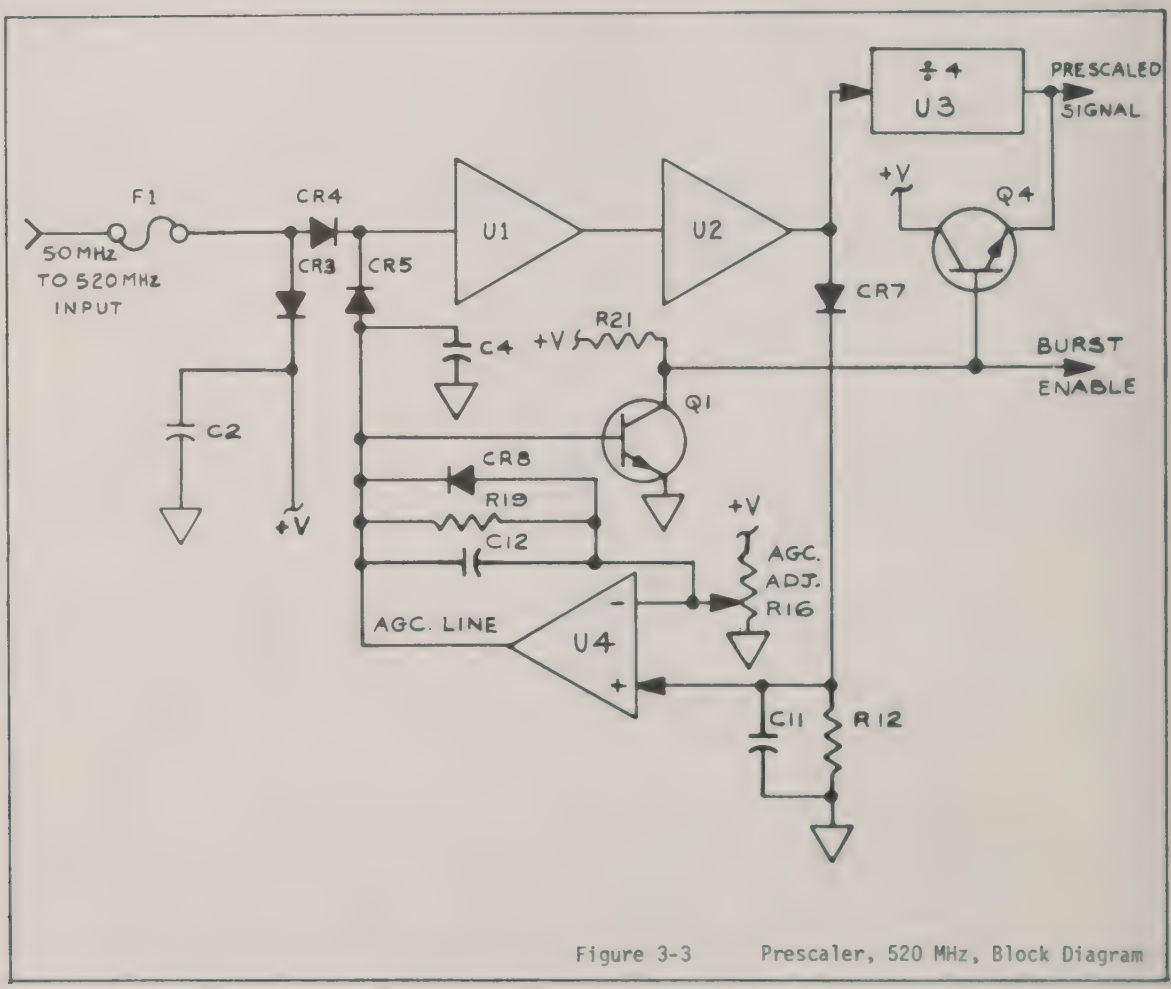

Figure 3-3 Prescaler, 520 MHz, Block Diagram

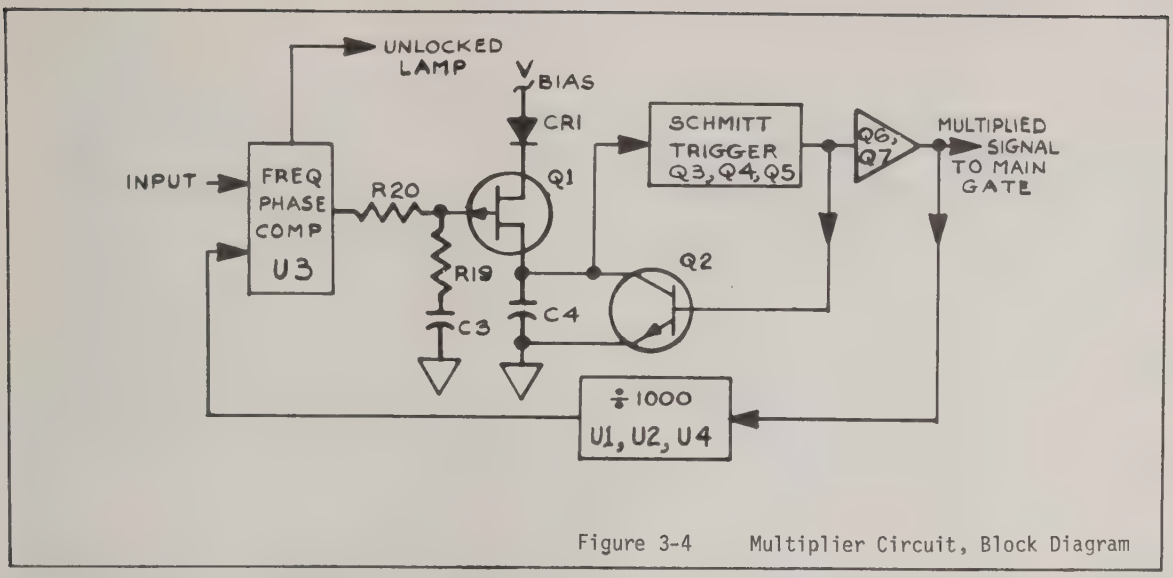

Figure 3-4 Multiplier Circuit, Block Diagram

3-23 MULTIPLIER CIRCUIT (OPTION-06)

3-24 The multiplier circuit is used in the high resolution mode of operation to increase the frequency of the input signal by a factor of 10^3, thereby permitting shorter gate times during low frequency measurements. When the high resolution mode is not selected on the front panel switch power is removed, and the entire circuit is disabled and consequently provides no output.

3-25 Figure 3-4 shows that the input signal is fed from the direct preamplifier to one input of a digital frequency/phase comparator. The second input to the comparator receives the actual output of the multiplier circuit after being divided by a factor of 10^3. When the output of the multiplier is exactly 1000 times greater than the input from the direct preamplifier, the two comparator inputs are in phase and a constant DC level is present at the VCO input. The comparator output filtered by R19, R20 and C3, drives Q1 and controls the charging rate of C4 through CR1. The voltage across C4 is applied to the input of a Schmitt trigger (which changes state at some threshold point). The Schmitt trigger causes Q2 to discharge C4, to begin the action over again.

3-26 The output of the Schmitt trigger is buffered and fed to the main gate and decade counters. The output is also divided by 1000 and fed back for comparison with the input from the direct preamplifier to form a phase-locked loop. Any frequency or phase difference between the two inputs will cause the output to change to maintain multiplied output equal to 1000 times the input. The phase comparator also provides a DC output to light the UNLK lamp and reset the counters whenever the multiplier is not locked in phase. This condition occurs during start-up or when an invalid input is present at the multiplier.

3-27 MAIN GATE / DECADE COUNTERS

3-28 The main gate is an integral part of the nine decade counters, as shown in Figure 3-5. The gating of the input signals from the direct preamplifier, prescaler, multiplier or time base oscillator to the decade counters is accomplished by applying an enable signal to the J and K inputs of the first stage of the first decade counter. Since the input pulses are applied to the clock input of the first stage, the J and K inputs must be True in order for the input pulses to toggle the first stage, which in turn, toggles the subsequent stages.

N O T E

Seven of the nine decade counters, the display memory, the display multiplex and measurement data bus described in these paragraphs are contained in a single LSI device, (See Parts Lists) and are not separately replaceable for the purpose of repair.

3-29 The main gate is enabled by the application of the main gate enable signal. When enabled, the first decade counter (least significant digit) receives the input pulses and on the count of ten, issues a carry pulse to the succeeding decade counter. The carry output of each counter becomes the input to the succeeding counter. The carry output of the most significant digit decade counter is used to generate the overflow signal, which lights the OVFL indicator.

3-30 DISPLAY MEMORY

3-31 The function of the display memory, shown in Figure 3-5, is to store the BCD contents of the decade counters after the measurement has been made, so that the multiplexer has access to settled data at all times. Without the display memory, the display would directly reflect the counting action of all the decade counters, making it difficult to observe the final measurement.

3-32 The display memory comprises a set of nine four-bit latches which accept their applied BCD inputs during the presence of a memory update command. The memory update command is generated by the control logic when it has determined that the contents of the decade counters are ready for display. (The control logic is described later in this section).

3-33 DISPLAY MULTIPLEXER

3-34 The function of the display multiplexer is to sequentially gate each digit of measurement data from the outputs of the display memory onto a bus which is commonly connected to all display LED's. In conjunction, the display multiplexer also enables the corresponding LED at the same time its respective measurement data is placed on the bus. As shown in Figure 3-5, the Display multiplexer comprises a series of nine four-bit gating circuits, an oscillator, a ten-stage ring counter and a measurement data bus (four-bit BCD). The oscillator drives the ten-stage ring counter through a complete cycle every millisecond. Each output is true for a period of 90 microseconds, providing a 10 microsecond guard period between each output.

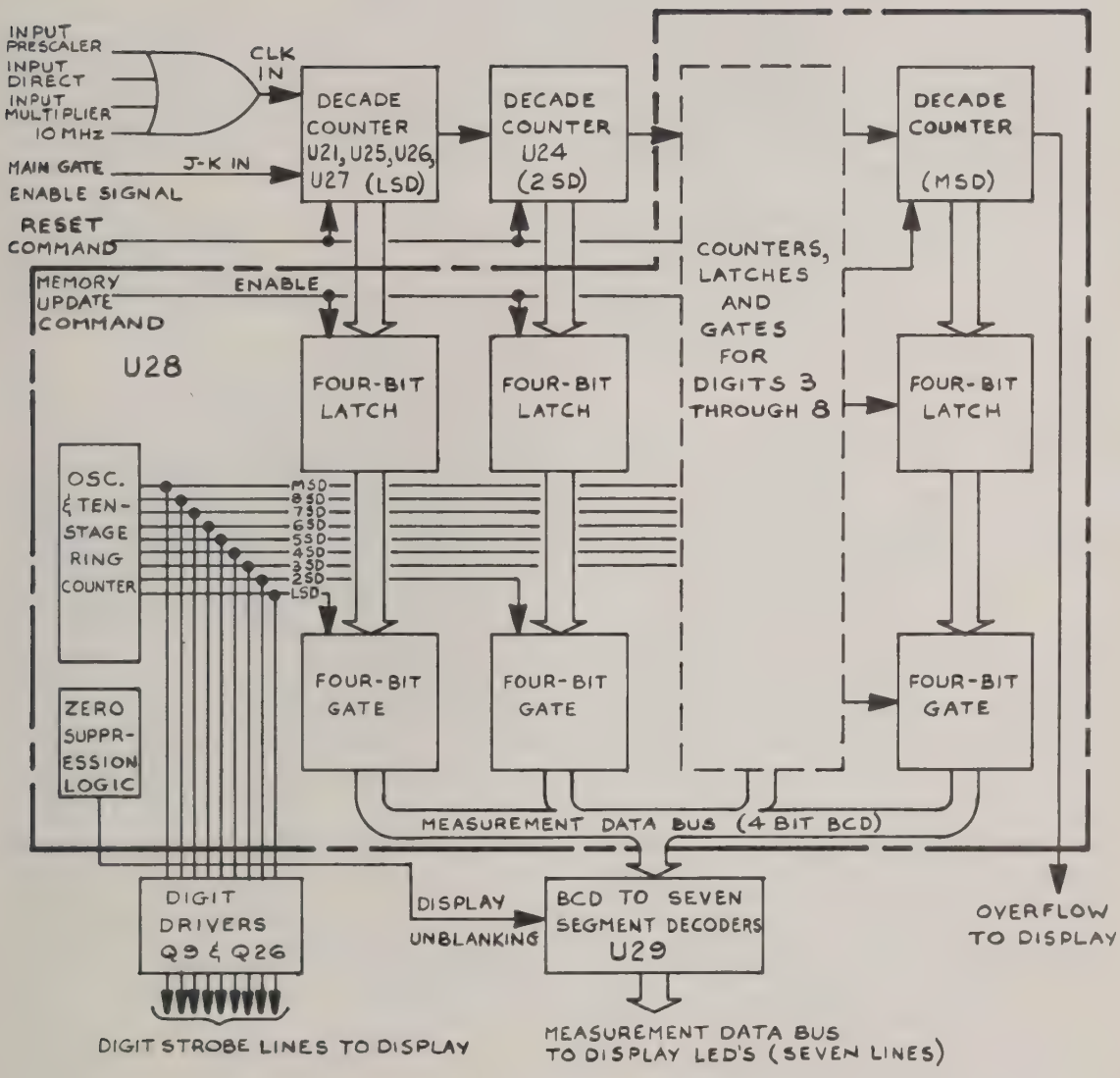

Figure 3-5 Decade Counters, Display Memory and Multiplexer, Block Diagram

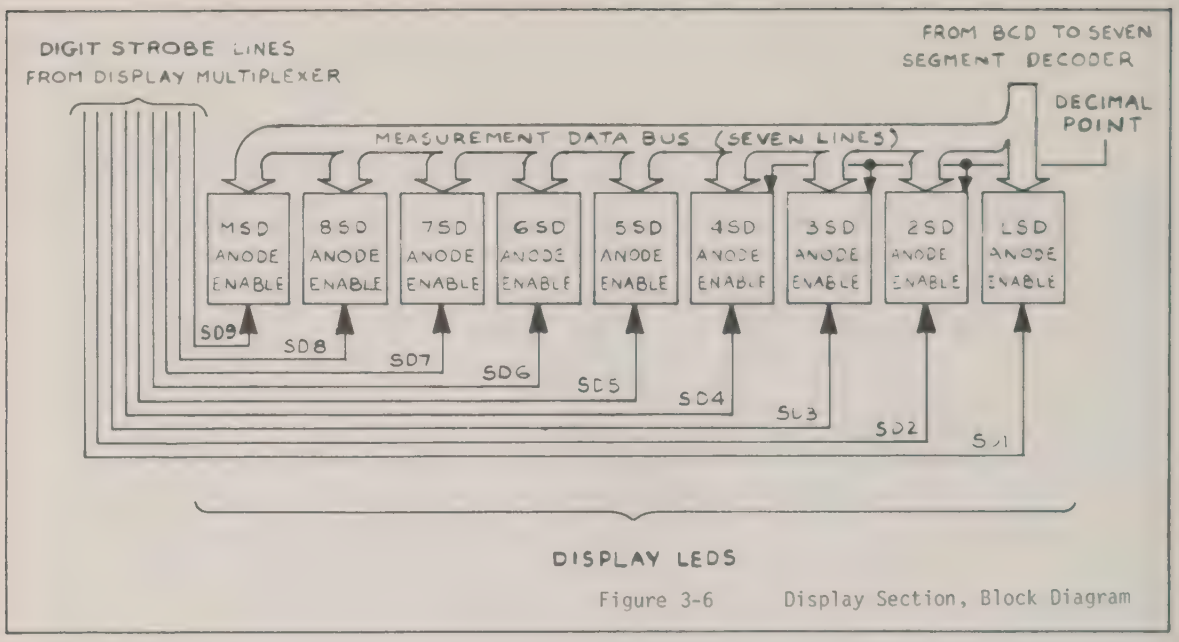

Figure 3-6 Display Section, Block Diagram

3-35 Nine of the ring counter outputs are used to enable the nine four-bit gating circuits, and their corresponding display LED's. The tenth output is used to reset the zero suppression logic. As the ring counter progresses through its cycle, each of the gating circuits is sequentially enabled for a period of 90 microseconds to place its respective digit of measurement data on the measurement data bus for application to the display LED's. At the same time the digit of measurement data is placed on the bus, the ring counter output feeds the digit strobe line, via the corresponding LED drivers, to enable the corresponding display LED. Refer to Figure 3-6.

3-36 Prior to application to the display, the BCD measurement data is decoded to the seven-line format required by the display LED's. The digit strobe lines are fed through a series of drivers for application to the anodes (enable inputs) of the display LED's.

N O T E

The BCD-to-seven segment decoder is inhibited by zero suppression logic whenever non-significant leading zeros are placed on the measurement data bus.

3-37 DECIMAL POINT POSITIONING

3-38 The position of the decimal point in the display is a function of the RESOLUTION switches and is determined by the coincidence of the digit strobe line and a signal on the decimal point bus shown in Figure 3-6. For example, if the 10 Hz RESOLUTION switch is pressed, then the SD2 strobe line is connected to the decimal point bus. Each time a pulse appears on the SD2 line, a pulse will appear on the decimal point bus. As a result, the 2SD LED receives a pulse on the

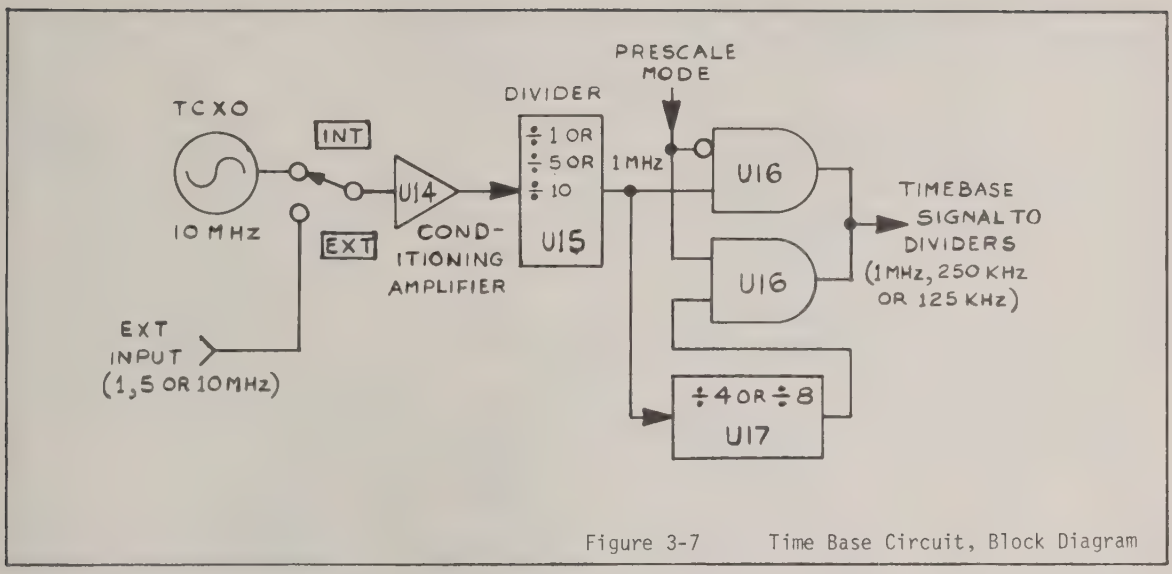

Figure 3-7 Time Base Circuit, Block Diagram

anode enable input at the same time a pulse is present on the decimal point bus. Since the pulse is present on the decimal point bus only during the period of SD2, only the 2SD decimal point lights.

3-39 TIME BASE OSCILLATOR

3-40 The time base oscillator provides the main gate base and comprises a TCXO, a conditioning amplifier and selectable dividers, as shown in Figure 3-7. The basic time base source may be the internal TCXO or an external source having a frequency of 1 MHz, 5 MHz or 10 MHz. The time base signal is fed via a conditioning amplifier to a programmable divider circuit.

3-41 The programmable divider has three division ratios (1:1, 5:1 and 10:1) to permit the use of the three different external time base frequencies, and is programmed by means of jumpers. The output of the programmable divider is 1 MHz which is further divided if operation is in the prescale mode. For the 520 MHz prescaler, a division ratio of 4:1 is used. For the optional 1 GHz and 1.25 GHz prescalers, a division ratio of 8:1 is used.

3-42 TIME BASE DIVIDERS

3-43 The function of the time base dividers, shown in Figure 3-8, is to divide the 1 MHz (250 kHz or 125 kHz in the prescale mode) time base signal by a selected power of ten to obtain the proper main gate enable signal. The time base dividers are contained within a single integrated circuit which receives division commands from the front panel RESOLUTION switches.

3-44 CONTROL LOGIC

3-45 The control logic, shown in Figure 3-8, controls the sequence of events which take place throughout the counter in order to make a measurement and display the result. The control

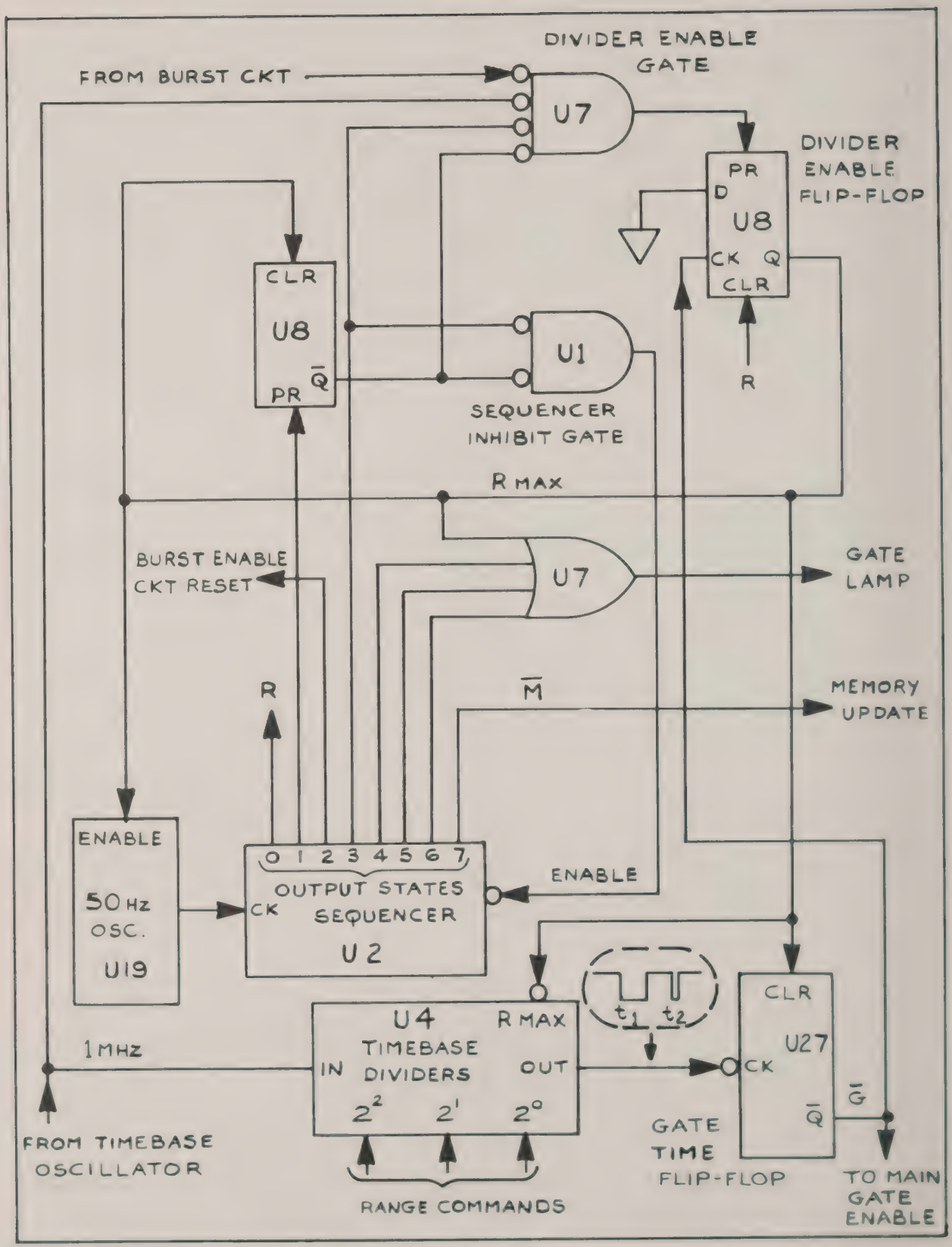

Figure 3-8 Timebase Dividers/Control Logic, Block Diagram

logic sequences through the measurement cycle at a rate determined by a 50 Hz relaxation-type oscillator and the selected gate time (resolution). The measurement cycle consists of the following basic steps:

a. A general reset command is issued to initialize the control logic and decade counters.

b. The main gate is enabled for a period of time which corresponds to the selected resolution. During this time, the decade counters accumulate the input pulses passed by the main gate. Also, the 50 Hz oscillator is inhibited during this time.

c. At the end of the main gate time, the main gate is inhibited and a memory update command is issued to load the display memory with the contents of the decade counters.

d. With the measurement data loaded into the display memory, the display multiplexer sequentially displays each digit of data the respective LED until the display memory is updated with the results of the succeeding measurement.

3-46 The following discussion describes the measurement cycle with reference to figure 3-8. As a starting point, assume the sequencer (U2), which is basically a ten-stage ring counter, is at count state zero. State zero is a general reset (R) command which is used to initialize the control logic and reset the decade counters to zero. The sequences advances to state one and presets U8, which enables one input of the divider enable gate (U7) and one input of the sequencer inhibit gate (U1). Twenty milliseconds later, the 50 Hz oscillator (U19) advances the sequencer to state two and resets the burst enable circuit (described later in this section).

3-47 State three of the sequencer enables the second input of the sequencer inhibit gate (U1) which prevents the sequence from advancing to state four. The state three output, also enables a second input of the divider enable gate. A third input is enabled by the burst enable circuit when a signal is present at the counter input, and the fourth input to the divider enable gate is provided when the timebase signal is at a low level. (The purpose of this fourth input is to synchronize the enabling of the time base dividers with the incoming time base signal). The output of the divider enable gate presets the divider enable flip-flop to produce the RMAX signal, which in turn, performs the following functions:

a. Enables the time base divider.

b. Inhibits the 50 Hz oscillator.

c. Clear U8, which in turn, inhibits the divider enable gate and removes the preset input from the divider enable flip-flop, U8 also removes the inhibit from the sequencer, although the absence of the 50 Hz oscillator signal still prevents any sequencer action.

d. Generates the GATE lamp signal.

e. Removes the clear signal from the gate time flip-flop.

3-48 For all states of the sequencer, except state three, the RMAX signal is high to reset and hold the time base divider at maximum count (i.e. 999.) and enable the 50 Hz oscillator. When the RMAX signal goes low ($\overline{RMAX}$), the time base dividers are allowed to count and will wrap-around to zero upon receipt of the first pulse of time base signal from the time base oscillator. When the time base dividers wrap-around to zero, a falling pulse-edge appears at the clock input of the gate time flip-flop (U27). This negative-going transition (t_1 in Figure 3-8) sets the gate time flip-flop and enables the main gate. During the time the main gate is enabled, the decade counters accumulate the input signal.

3-49 Also during this time, the time base dividers are being allowed to count the input pulses (time base signal) being applied to their input. This action continues until the time base dividers reach full count (i.e. 999.) and wrap-around to zero again, to produce a second negative-going transition (t_2 in Figure 3-8) at the clock input of the gate time flip-flop. At this time (t_2), the gate time flip-flop is reset, the main gate is inhibited and no further input pulses reach the decade counters. The positive-going output of the gate time flip-flop also resets the divider enable flip-flop (U8) since the preset input has been removed. With the divider enable flip-flop reset, the RMAX signal is high to reset and hold the time base dividers at full count.

3-50 The 50 Hz oscillator is enabled by the high RMAX signal and the sequencer advances from state three to states four, five and six. Each of these states have a period of 20 milliseconds, and each prolong the GATE lamp signal for a cumulative total of 80 milliseconds plus the actual gate time of 1, 10, 100, 1000 or 10,000 milliseconds. This enables the operator to observe the GATE lamp when the shorter gate times are selected.

3-51 When the sequence advances to state seven, a memory update command is generated and fed to the display memory. The memory update command causes the display memory to be updated to the last measurement. The measurement is then multiplexed and displayed. States eight and nine are not used and the sequencer proceeds to state zero to begin the next measurement cycle.

3-52 BURST ENABLE CIRCUIT

3-53 The main function of the burst enable circuit is to inhibit and enable the previously described measurement cycle at the proper times for the purpose of measuring the frequency of keyed RF inputs to the counter. During normal counter operation (not using the burst mode), the front panel BURST switch places positive voltage on the burst flip-flop, shown in Figure 3-9, to hold it in the preset state. In the preset state, the burst flip-flop maintains a low output to enable one input of the divider enable gate shown in Figure 3-8, allowing the measurement cycle to be controlled entirely by the previously described sequencer and time base dividers.

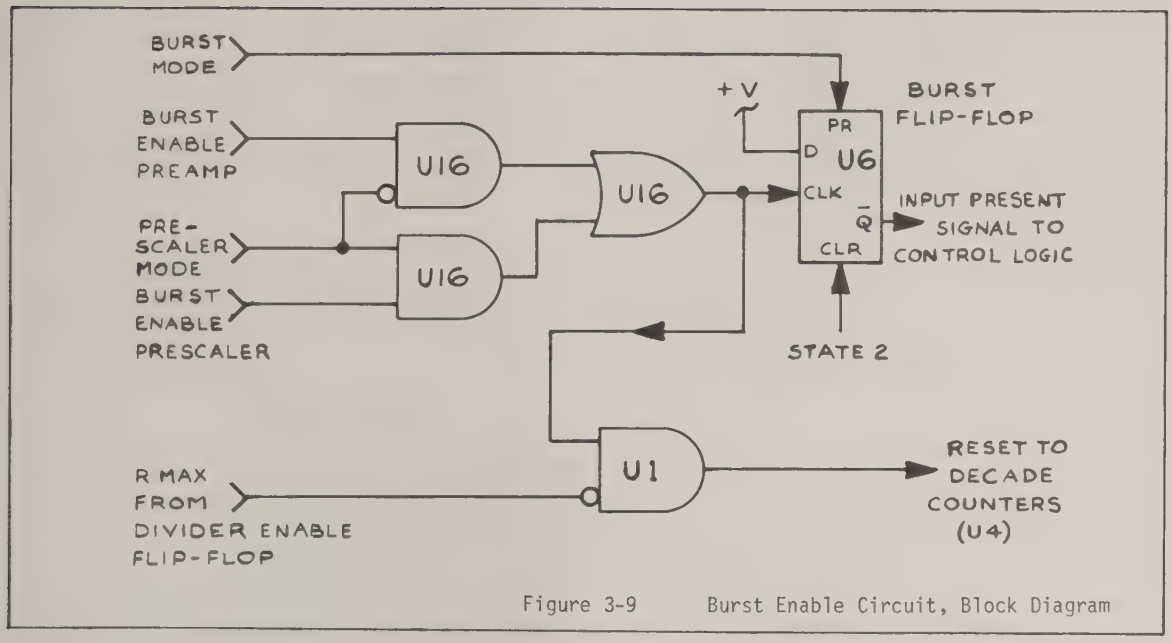

Figure 3-9 Burst Enable Circuit, Block Diagram

3-54 In the burst mode, the preset voltage is removed from the burst flip-flop, allowing it to be clocked and cleared. State two of the sequencer clears the burst flip-flop to inhibit the divider enable gate (Figure 3-8). As a result, the sequencer is halted at state 3 as in normal operation, but the time base dividers are not yet allowed to count the time base signal and clock the gate time flip-flop. When an input signal is received at the direct preamplifier or the prescaler (depending on the selected mode), the burst flip-flop is clocked to the set state and the time base dividers are enabled. From this point, the measurement cycle proceeds in the manner described for normal operation until state three is again reached. The control logic will again halt at state three until a burst enable signal is received from one of the inputs.

3-55 To prevent erroneous measurements, which would result if the RF burst under measurement were of shorter duration than the selected gate time, a reset function is included to abort the measurement by zeroing the decade counters. As shown in Figure 3-9, the burst enable signal is applied to an AND gate with the RMAX signal. If the burst enable signal drops (due to loss of input signal) before $\overline{\text{RMAX}}$ goes high at the end of the main gate time, a reset signal will be applied to all decade counters, forcing them to zero. This reset feature also operates in the normal mode to prevent erroneous readings when inputs of marginal levels are applied, etc.

3-56 BATTERY CHARGER AND INVERTER

3-57 As shown in Figure 3-10 the battery PCB contains the batteries, the battery charger and the inverter. The charger is a constant current type supplying 400 mA charge to the batteries when the unit is not operating. This reduces to approximately 120 mA when the unit is operating.

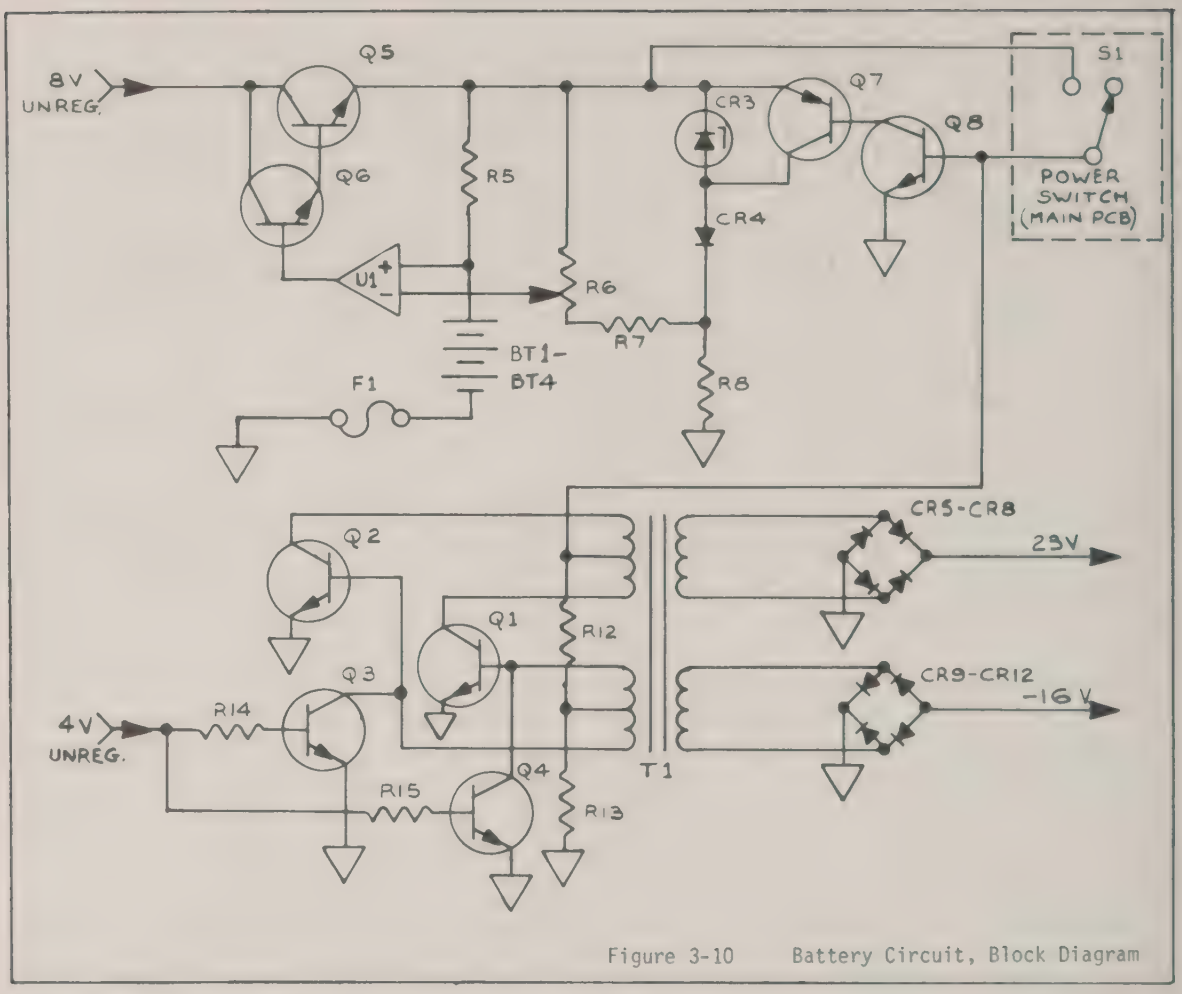

Figure 3-10 Battery Circuit, Block Diagram

3-58 R6,R7,R8,CR3 and CR4 establish a reference voltage which is fed to one input of U1. The voltage drop across R5 is fed to the other input of U1. The output of U1 controls the charge current through Q5 and Q6. Q7 and Q8 turn on when the unit is operating to reduce the reference voltage and hence the charge current. Fuse F1 protects the battery from short circuits.

3-59 Q1,Q2 and T1 form an oscillator running at approximately 5 kHz. The transformer outputs are rectified to provide 23 V and -16 V inputs to the regulators. Q3 and Q4 turn the oscillator off when the unit is operating from the AC power line.

3-60 DIGITAL OUTPUT UNIT

3-61 The digital output unit as shown in Figure 3-11 contains ten latches U3-U6 and U8-U13. Nine of the latches are sequentially strobed with the nine digits of the readout. The tenth latch (U8) stores the decimal and overflow information. One half of U2 is used to strobe the decimal information into U8. The other half generates a print command every time the display memory is updated. The output of the DOU will thus change synchronous with the display.

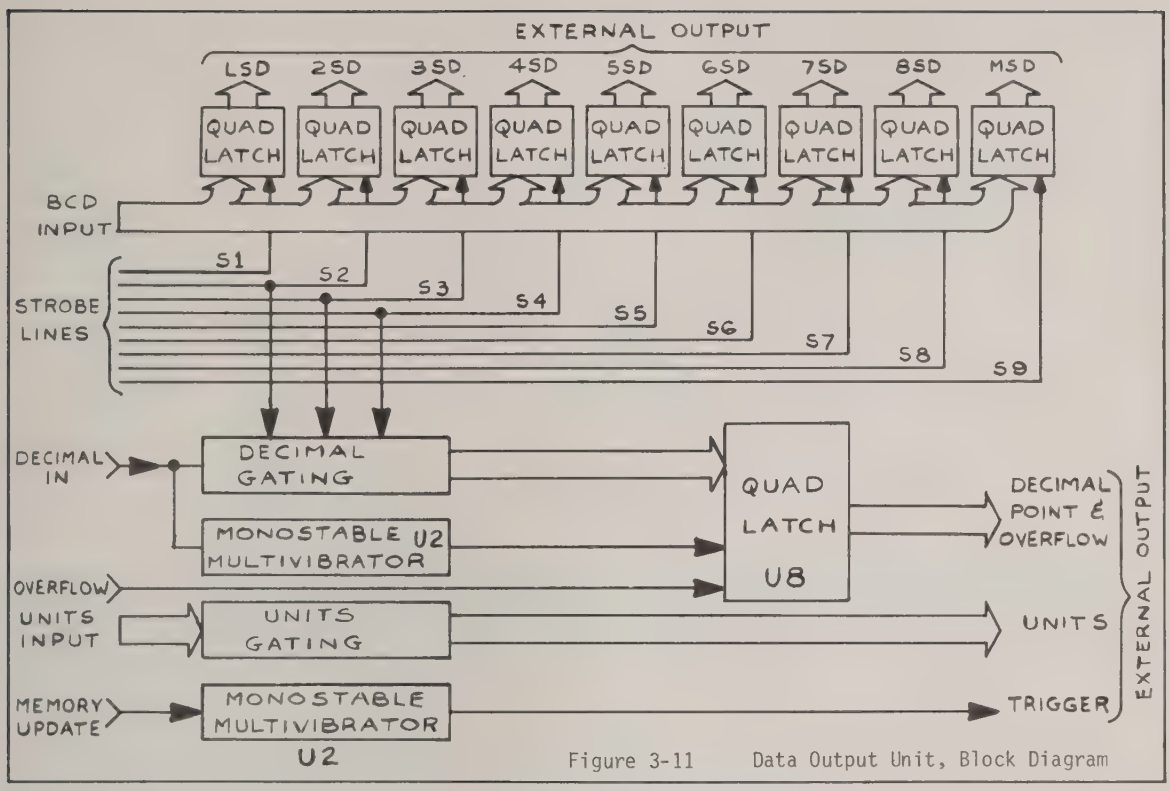

Figure 3-11 Data Output Unit, Block Diagram

3-63 The main function of the prescaler is to reduce the frequency of the input signal to below 160 MHz for application to the main gate and decade counters. The prescaler also provides the necessary conditioning of the input signal to provide sufficient gain and the proper waveshaping. The frequency division factor for the prescalers is eight.

3-64 As shown in figure 3-12 the input signal is fed through an input protection fuse, F1, to the input of the amplifier, which contains input limiting. The output of the amplifier, which is also internally limited, is applied to a divider circuit which divides by a factor of eight to reduce the input frequency to below 160 MHz. The prescaled signal, amplified by U1 and divided by U2 and U3 is fed to the main PCB assembly for application to the main gate and decade counters.

3-65 The output of the amplifier is sensed via CR1 and U4 to detect signals whose level is too low to reliably clock the divider circuit. When a low signal level is detected, the divider output is disabled and a signal is provided to the main PCB preventing the gate from opening, causing the display to read zero. This signal is also used in the Burst Measurement mode to detect the burst signal.

NOTE

The prescaler like the direct preamplifier is energized only when that mode is selected. When not selected the front panel mode switch interrupts its power supply connection.

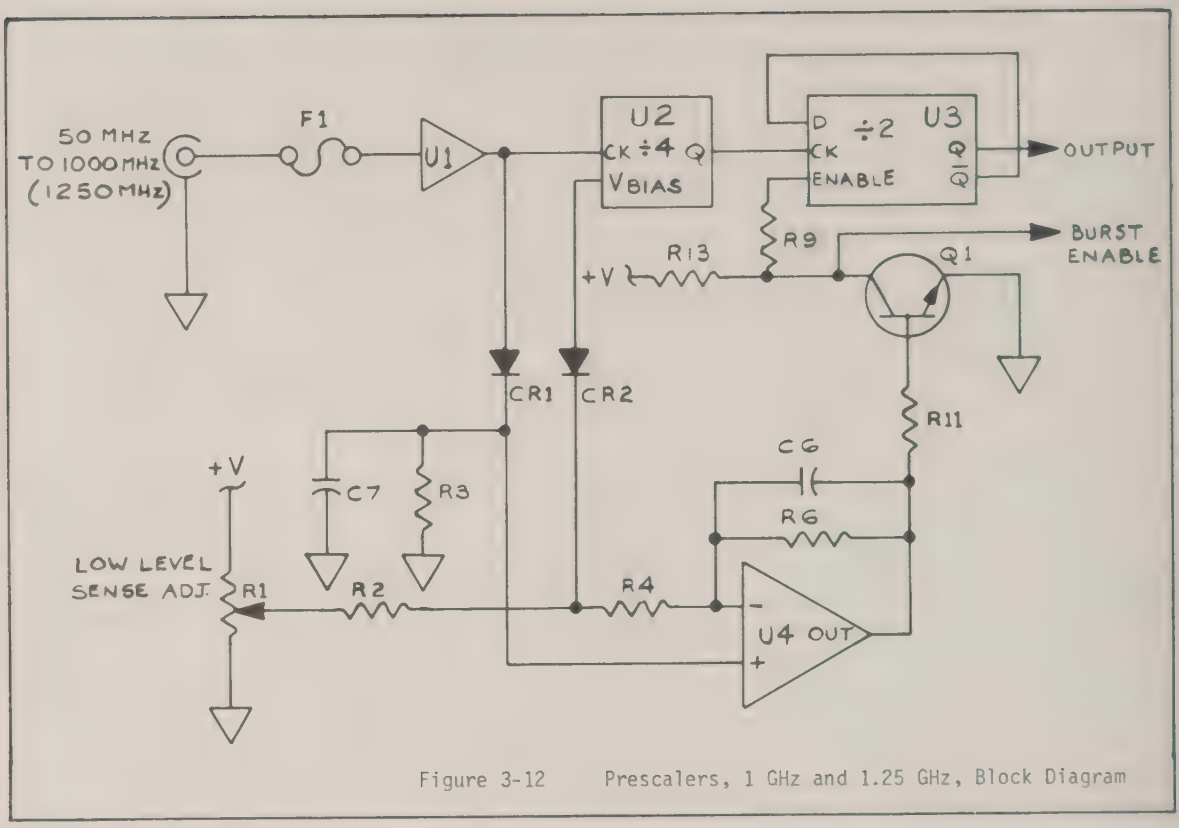

Figure 3-12 Prescalers, 1 GHz and 1.25 GHz, Block Diagram

Section 4

Maintenance

4-1 INTRODUCTION

4-2 This section contains information concerning preventive and corrective maintenance for the Model 1920A. Equipment for performing maintenance tests and adjustments is listed in Table 4-1. If this equipment is not available, other equipment having equivalent specifications may be used.

Table 4-1 Test Equipment Required

EQUIPMENT TYPE	REQUIRED BASIC SPECIFICATIONS	WHERE USED	RECOMMENDED MANUFACTURER
Quartz oscillator frequency standard with 10 or 1 & 5 or 50 MHz output	Short term stability to be better than 1×10^{-8} Long term stability to be better than 1×10^{-9} @ 0 - 50°C ambient temperatures	Time Base Oscillator Adjustment	
Low Frequency Oscillator	Frequency Range: DC - 10 MHz; Variably attenuated output from 1 mV rms to 1 V or 5 V rms @ 50 ohms output impedance.; selectable sinewave and square wave modes;	Performance Check; Calibration	HP 204 D

EQUIPMENT TYPE	REQUIRED BASIC SPECIFICATIONS	WHERE USED	RECOMMENDED MANUFACTURER
High Frequency Oscillator	Frequency Range: 10 MHz - 1.3 GHz; variably attenuated calibrated output from 1 mV to 1 V or 5 V rms (50 ohms output impedance); CW mode	Performance Check; Calibration	Wavetek 2001
RF Millivoltmeter	Frequency Range: 10 kHz - 1.3 GHz; Volt. Range: 1 mV - 5 V rms Accuracy: Maximum 3% of reading @ 1250 MHz + 1% full scale VSWR: Less than 1:1.15 @ 1.2 GHz Power Sensitivity: 200 pW @ 50 ohms Basic Accessories: a. 50 ohms BNC Adapter; b. TYPE N TEE ADAPTER, unterminated	Performance Check; Calibration	Boonton 92 - B - C - D
Multimeter	Capable of measuring DC & AC voltage: DC & AC current; Resistance DC VOLTAGE RANGE of ± 199.9 mV to · 1999 V with accuracy better than · 1% of reading AC VOLTAGE RANGE of 199.9 mV to 1999 V with accuracy better than ± 1.5% of reading DIRECT CURRENT RANGE of ± 199.9 uA to · 1999 mA with accuracy better than · 1% of reading ALTERNATING CURRENT RANGE of 199.9 uA to 1999 mA with accuracy better than ± 1.5% of reading	Troubleshooting	Fluke 8000A Series

EQUIPMENT TYPE	REQUIRED BASIC SPECIFICATIONS	WHERE USED	RECOMMENDED MANUFACTURER
Multimeter	RESISTANCE RANGE of 199.9 ohms to 19.99 M ohms with accuracy better than ± 1% of reading		
Oscilloscope	DUAL TRACE; 200 MHz BANDWIDTH; 2 mV per division sensitivity; TIME BASE @ 0.05 us/div. with time delay features	Troubleshooting	Tektronix 475

4-3 SERVICE INFORMATION

4-4 Should your instrument need repair, send it to the nearest factory authorized service center. A list of these authorized service centers is located on the inside of the front cover. Also located on the inside front cover is the WARRANTY which warrants the instrument for a period of one year.

4-5 GENERAL MAINTENANCE

4-6 ACCESS

4-7 Use the following procedure to gain access to the interior of the Model 1920A.

a. With the power switch OFF, disconnect the line cord.

b. Remove the two Phillips screws at the rear of the instrument case.

c. Remove the instrument from the case.

4-8 CLEANING

4-9 Clean the front panel and case with denatured alcohol or mild solution of detergent and water. Do not use aromatic hydro-carbons or chlorinated solvents because they will react with the plastic materials of the instrument.

4-10 FUSE REPLACEMENT

4-11 The input power fuse, F1, is located within the instrument in a fuse clip at the rear of the unit. To gain access to the fuse, refer to paragraph 4-6. When replacement is required, install a MDL 1/4A (slow acting) fuse.

4-12 The prescaler input fuse is located on the prescaler PCB assembly, and is mounted in a socket. To gain access to the fuse, refer to paragraph 4-6. When replacement is required, install Little-Fuse type 273.200, 2/10A.

4-13 The battery fuse is located on the battery PCB. To gain access to the fuse refer to paragraph 4-14. When replacement is required install a MDL 3A (slow acting) fuse.

4-14 BATTERY REPLACEMENT (OPTION-01)

4-15 Follow the disassembly instructions below for removing the replaceable batteries in the Model 1920A-01.

CAUTION

1. Damage may result if alkaline, zinc-carbon or mercury batteries are re-charged in the instrument.
2. Do not remove or install batteries before disconnecting line cord from mains.

a. Disconnect line cord. Remove two retaining screws at rear of instrument case, and remove instrument from case.

b. Remove the five screws as shown in figure 5-1 (3 of 4).

c. Pull left side chassis outwards and lift Battery PCB out of unit.

d. Detach P6 from J6.

e. If it is desired to return operation of the unit to A C only, remove the shorting plug (P7) in J7 and replace it in J6.

f. Remove the two threaded bolts securing battery holders.

g. Remove the holder tops and batteries.

h. Replace the batteries with 1.2 Volt nickel-cadmium batteries (JF Part No. 346924). Install as indicated in figure 5-10.

4-16 PERFORMANCE CHECKS

4-17 The performance checks provide a means of verifying overall operation of the Model 1920A. The checks can be used as an acceptance check during incoming inspection or as a periodic maintenance check. Refer to Table 4-1 for a list of required test equipment. Equivalent equipment may be used.

4-18 FUNCTIONAL CHECK

4-19 To perform a functional check of the Model 1920A, refer to the self-check described in paragraph 2-16.

4-20 SENSITIVITY CHECK (DIRECT PREAMPLIFIER)

4-21 Perform the checks as follows:

a. Connect the generator, set for 5 Hz at 15 mVrms to the counter input.

b. Slowly reduce the input level and confirm that display goes to zero before readings become unstable or incorrect and that input is below 15 mVrms.

c. Repeat b. at 100 Hz, 10 kHz, 1 MHz, 10 MHz, 20 MHz, 40 MHz, 60 MHz, 80 MHz and 100 MHz.

d. Repeat b. at 125 MHz and confirm input level is below 25 mVrms.

4-22 SENSITIVITY CHECK (PRESCALER)

4-23 Perform the sensitivity check as follows:

a. Connect the generator, set for 50 MHz at 15 mVrms to the counter input.

b. Slowly reduce the input level and confirm that the display goes to zero before readings become unstable or incorrect.

c. Repeat b. approximately every 100 MHz to the upper limit of the Prescaler.

d. Up to 1000 MHz confirm that the sensitivity is less than 15 mVrms. From 1000 MHz to 1250 MHz confirm that the sensitivity is less than 30 mVrms.

4-24 ACCURACY CHECK

4-25 The accuracy of the 1920A is a function of ambient temperature, line voltage and time since calibration. For example, assume an ambient temperature of 25°C, line voltage ·10· and six months since last calibrated to 10.00 MHz ±1 Hz. A 10.00 MHz Frequency standard measured at 1 Hz resolution will read 10000.000 kHz ± 28 Hz maximum.

4-26 CALIBRATION

4-27 Calibration of the Model 1920A comprises adjustment of the internal TCXO, the trigger, AGC and threshold levels of the direct preamplifier and the AGC level of the 520 MHz Prescaler or the low level sense of the 1000 MHz or 1250 MHz Prescalers. These adjustments should be made after any repairs to the corresponding area.

4-28 DIRECT PREAMP TRIGGER LEVEL, AGC AND THRESHOLD ADJUSTMENT

4-29 Adjust the Trigger, AGC and Threshold levels as follows:

a. Set FREQUENCY to 5 Hz - 125 MHz and RESOLUTION to 1 kHz.

b. Connect High Frequency Signal Generator and RMS voltmeter terminated by a 50 ohm load to 5 Hz - 125 MHz input.

c. Set AGC trimpot (R10), and THRESHOLD trimpot (R11), to maximum clock-wise position.

d. Set Generator to 125 MHz at 25 mV (rms)

e. Adjust TRIGGER potentiometer (R30) to a midpoint which produces a stable and correct display.

f. Reduce input level until display becomes unstable.

g. Readjust TRIGGER level for a stable display.

h. Repeat f. and g. until no additional increase in sensitivity is possible.

i. Set input frequency to 10 MHz.

j. Reduce input level to the minimum value which still produces a stable and correct reading.

k. Slowly advance AGC trimpot counter-clockwise until reading becomes unstable or incorrect.

l. Slowly advance AGC trimpot (R10) clockwise until reading becomes stable and correct.

m. Repeat k. and l. for THRESHOLD trimpot (R11).

n. Slowly Reduce input level ensuring that drop-out is clean.

o. Slowly Increase input level until display is stable and correct. Ensure that input level is less than 13 mV (rms). Readjust THRESHOLD trimpot if necessary for clean drop-out.

p. Repeat n. and o. at 100 MHz, 50 MHz, 20 MHz and 10 MHz.

q. Repeat n. and o. at 125 MHz, ensuring that input level is less than 20 mV (rms).

r. Connect low frequency generator and repeat n. and o. at 5 Hz, 10 Hz, 100 Hz, 10 kHz, 1 MHz and 5 MHz.

4-30 520 MHZ PRESCALER AGC ADJUSTMENT

4-31 Adjust the AGC control on the 520 MHz prescaler PCB assembly as follows:

a. Set frequency to 50 MHz - 520 MHz.

b. Connect High Frequency Generator and rms Voltmeter with high impedance probe to 50 MHz - 520 MHz input.

c. Set Signal Generator to 50 MHz at 15 mV rms.

d. Set AGC trimpot R15 on PRESCALER PCB to fully clockwise position. Rotate trimpot slowly counter-clockwise until display is at correct frequency of 50 MHz.

e. Reduce input level until display goes to zero or becomes unstable. If display becomes unstable readjust AGC trimpot (R15) until display goes to zero without becoming unstable first.

f. Set Signal Generator to 75 MHz at 15 mV and repeat e.

g. Repeat f. at 100 MHz, 200 MHz, 300 MHz, 400 MHz and 520 MHz.

i. Set Signal Generator to 50 MHz at 15 mV. Slowly decrease input level until display goes to zero. Note input level. Slowly increase input level until display reads 50 MHz. Note input level. Difference should be 1 to 2 mV. Slowly advance AGC trimpot counter-clockwise until display reads zero.

4-32 1000 MHZ AND 1250 MHZ PRESCALER LOW LEVEL SENSE ADJUSTMENT

4-33 To adjust the 1000 MHz and 1250 MHz Prescaler low level sense adjustment proceed as follows:

a. Connect a High Frequency Generator and AC RMS Voltmeter with high impedance probe to the counter input.

b. Set cutout trimpot (R1) to maximum clockwise position.

c. Set input frequency to 50 MHz at 15 mV rms.

d. Reduce input level until display becomes unstable then slowly increase level until display becomes stable and correct.

e. Advance cutout trimpot slowly counter-clockwise until display reads zero.

f. Note input voltage is less than 13 mV. Slowly increase input level until display again reads input frequency. Difference should be 1 to 3 mV.

g. Set input frequency to 100 MHz at 15 mV rms.

h. Reduce input level until display reads zero. If display becomes unstable before going to zero repeat d. and e.

i. Repeat g. and h. approximately every 100 MHz to 1000 MHz.

j. For 1250 MHz unit (-14 Option) repeat g. and h. at 1100 MHz, 1200 MHz and 1250 MHz ensuring input voltage is less than 25 mV rms.

4-34 TIME BASE OSCILLATOR ADJUSTMENT

4-35 Time base oscillator adjustment should be made when ever the oscillator is repaired, or whenever it is determined that accuracy of the counter is not within the accuracy desired. Perform time base oscillator adjustment in an environment having an ambient temperature of +22°C to +25°C (72°F to 77°F).

4-36 The time base oscillator output frequency can be accurately set using either of the two methods given. The first method, using a frequency standard for the reference, should be used whenever a standard is available. The second method uses the WWV broadcast frequency as the calibration standard, and may be used whenever a more suitable frequency standard is not available.

4-37 TIME BASE ADJUSTMENT USING A FREQUENCY STANDARD

a. Energize the counter and allow it to warm-up for one hour.

b. Remove the counter from the case (paragraph 4-6)

c. Connect the 10 MHz frequency standard to the 5 Hz - 125 MHz input.

d. On the counter, select the 0.1 Hz resolution.

e. While observing the display, adjust the TCXO (accessed either through the PCB or rear panel, depending upon the type installed) to obtain a reading of 10000.0000 +10 digits. (10000.0000 ± 3 digits, option -04)

4-38 TIME BASE ADJUSTMENT USING WWV

4-39 This procedure requires the counter to be in close proximity to the receiver antenna lead-in cable.

a. Allow unit to warm-up for one hour.

b. Remove the outer cover of the 1920A counter.

c. Tune the SW receiver to the 10 MHz WWV broadcast.

d. Bring the counter near enough to the SW receiver antenna lead so that a zero beat note can be heard on the receiver's speaker. If insufficient radiation is picked up from the counter, turn the time base oscillator towards the antenna and move it in close.

e. Adjust the TCXO (accessed either through the PCB or rear panel), depending upon the type installed for a "zero beat" on the receiver.

f. Observe the receiver signal level meter, and adjust the TCXO for an exact null. This will put the timebase oscillator output frequency within 1 Hz of the 10 MHz requirement.

4-40 TROUBLESHOOTING

4-41 The following information is designed to aid in troubleshooting the Model 1920A. Fault isolation is achieved by executing the self-check described in Section 2 and noting failure symptoms. Figures 4-1 and 4-2 list several failure symptoms and the possible causes. Use these figures as troubleshooting guides in conjunction with the theory of operation presented in Section 3.

4-42 Provision is made to check all segments of all LED's for the purpose of determining whether or not a dark segment(s) is due to a faulty LED or other circuitry. To light all segments of all LED's select the self-check function and depress RESET switch. All segments should light.

4-43 REPAIR TECHNIQUES

4-44 Battery-Powered Instruments

4-45 To facilitate access to components, before attempting any repair on a battery-powered unit remove the battery option completely and convert the unit to ac line operation. Remove the battery option following the procedure for battery replacement given in section 4-14.

4-46 Integrated Circuit Replacement - CMOS and PMOS Types.

4-47 Table 4-2 lists the MOS types of integrated circuits used in the Model 1920A, for reference during repair. CMOS and PMOS integrated circuits can be destroyed by electrostatic discharge resulting from careless handling. During any repair or replacement procedure involving the handling of these types of integrated circuits, observe the following precautions to prevent damage.

a. CMOS and PMOS integrated circuits are supplied packed in conductive foam. Do not remove the conductive foam from the integrated circuit until ready for installation.

b. Ensure that the repairing personnel and the unit under repair are commonly grounded.

c. Ensure that the soldering iron used is grounded to the common ground.

Table 4-2 MOS - Type Integrated Circuits

Reference Designator			Type
Multiplier	PCB	U3	CD4046
Main	PCB	U1	CD4001
Main	PCB	U2	CD4017
Main	PCB	U3	CD4049
Main	PCB	U4	MK5009
Main	PCB	U5, U29	CD4050
Main	PCB	U6, U8	CD4013
Main	PCB	U7	CD4002
Main	PCB	U9	CD4023
Main	PCB	U28	1801A
DDU	PCB	U1, U7	CD4011
DDU	PCB	U2	MC14528
DDU	PCB	U3-U6, U8-U13	CD4042
Display	PCB	U1	CD4049
		U2	CD4001

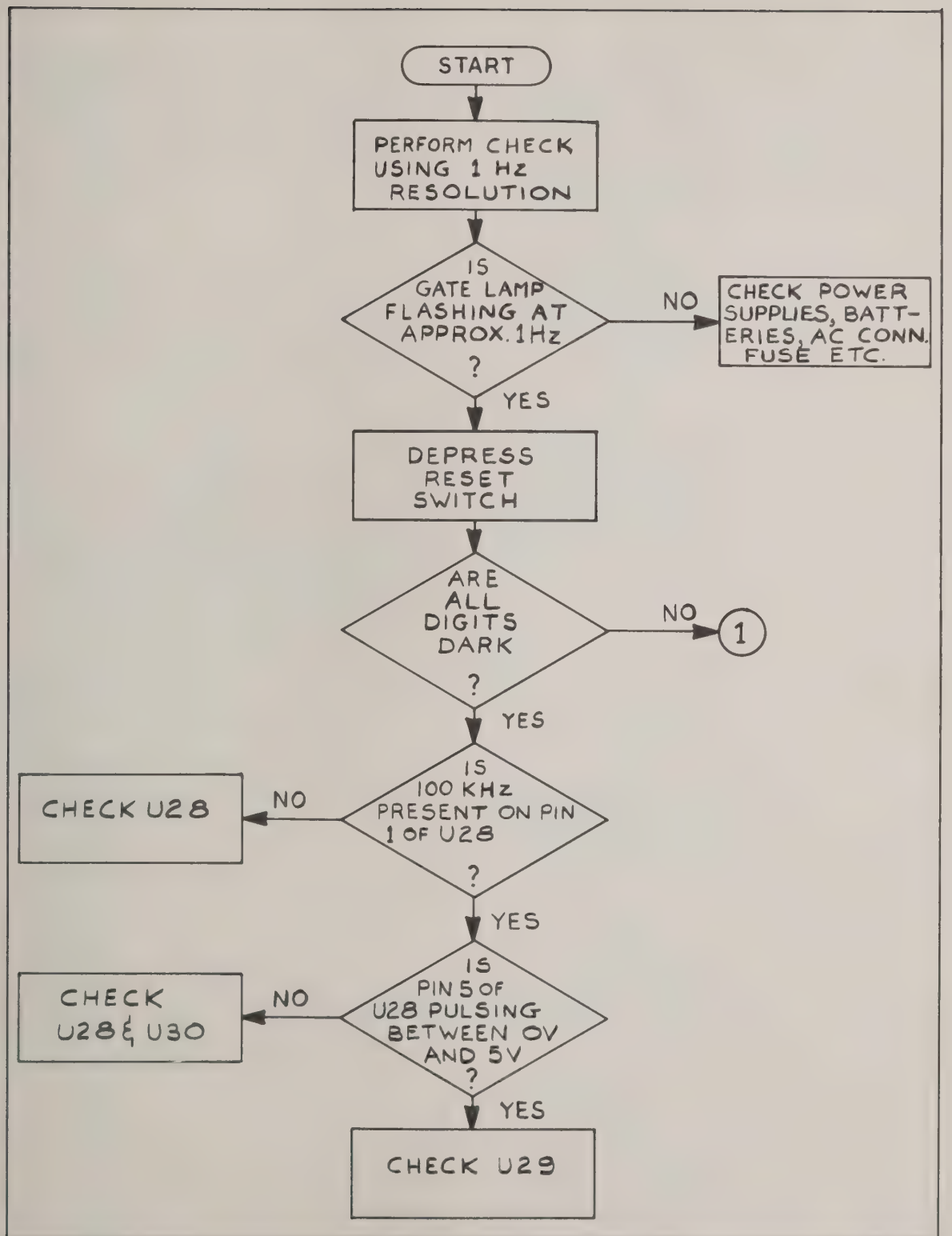

Figure 4-1 Fault Isolation, Display Problems

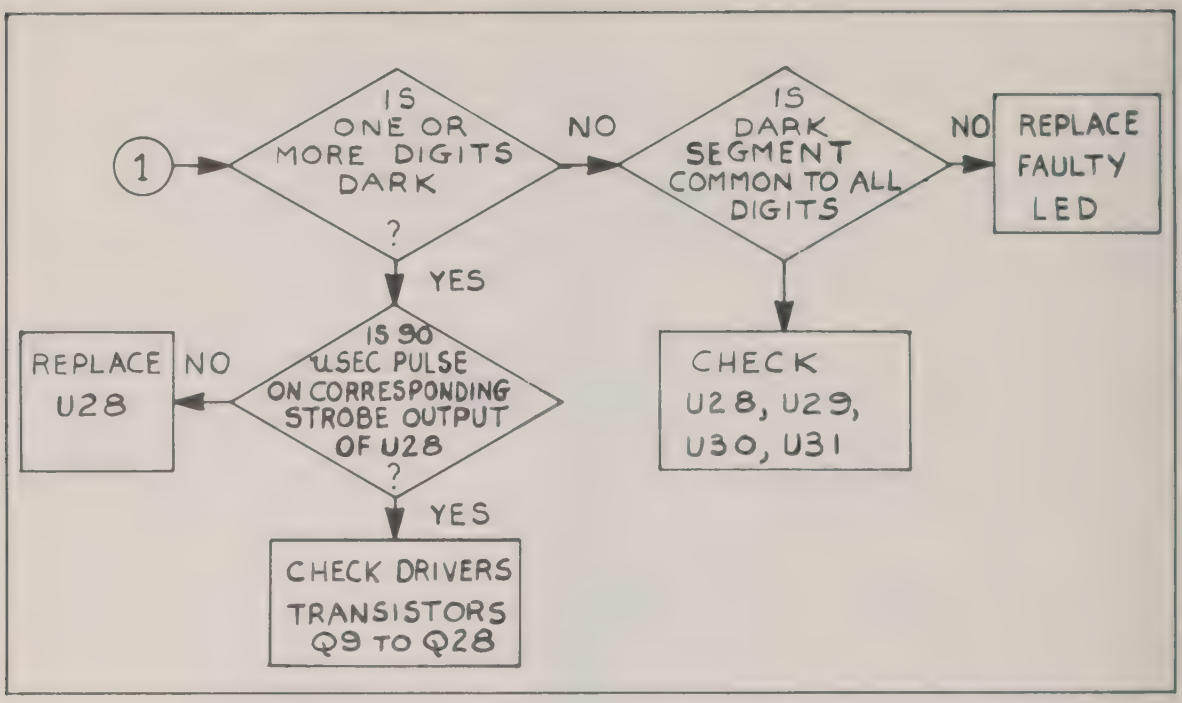

Figure 4-1 Fault Isolation, Display Problems (Continued)

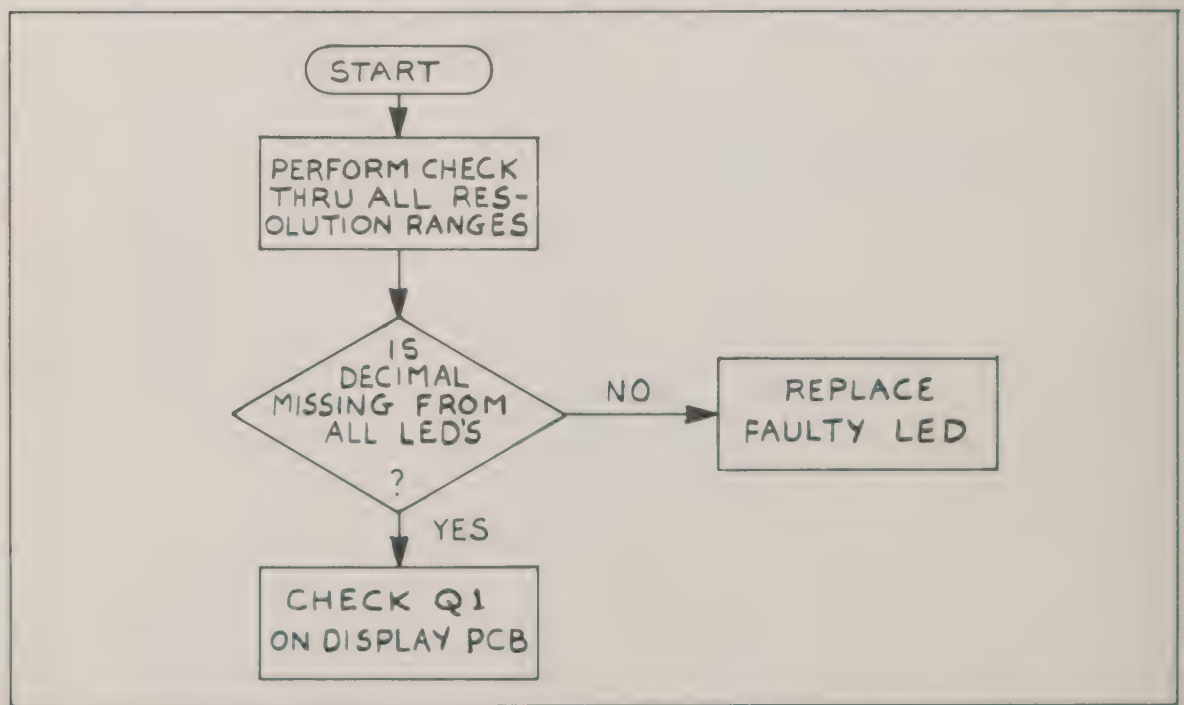

Figure 4-2 Fault Isolation, No Decimal

Section 5

Lists of Replaceable Parts

ASSEMBLY NOMENCLATURE	PART NO.	PAGE
Final Assembly	399030	5 - 4
Case Assembly	398438	5 - 10
Front Panel Assembly	398447	5 - 12
Display PCB Assembly	398321	5 - 14
Main PCB Assembly	398305	5 - 15
Prescaler PCB Assembly - 520 MHz	396291	5 - 20
Direct Preamplifier PCB Assembly	398347	5 - 22
Multiplier PCB Assembly	398388	5 - 25
Battery PCB Assembly	398404	5 - 27
Data Output Unit PCB Assembly	398420	5 - 30
Prescaler PCB Assembly - 1000 MHz	396309	5 - 32
Prescaler PCB Assembly - 1250 MHz	405597	5 - 34

5-1 INTRODUCTION

5-2 This section contains an illustrated parts breakdown of the instrument. Components are listed alpha-numerically by assembly. Electrical components are listed by reference designation and mechanical components are listed by item number. Each listed part is shown in an accompanying illustration.

5-3 Parts lists include the following information:

a. Reference Designation or Item Number.

b. Description of each part.

c. Fluke Stock Number.

d. Federal Supply Code for Manufacturers. (See Appendix A for Code-to-Name list).

e. Manufacturer's part Number or Type.

f. Total Quantity per assembly or component.

g. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site it is recommended that at least one in each assembly in the instrument be stocked. In the case if optional sub-assemblies, plug-ins, etc. that are not always part of the instrument, or are deviations from the basic instrument mode, the REC QTY column lists the recommended quantity of the item in that particular assembly.

h. The Use Code is provided to identify certain parts that have been added, deleted or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity, paragraph 5-7.

5-4 HOW TO OBTAIN PARTS

5-5 Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co. Ltd. factory or authorized representative by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-6 To ensure prompt and efficient handling of your order, include the following information.

a. Quantity.

b. FLUKE Stock Number.

c. Description.

d. Reference Designation or Item Number.

e. Printed Circuit Board Part Number.

f. Instrument model and Serial number.

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	FINAL ASSEMBLY MODEL 1920A						
	Figure 5-1						
	1. 115V/230V	400077	89536	400077	1		
	2. 100V		89536		1		
	1920A INSTRUCTION MANUAL	400101	89536	400101	1		
1	Main PCB Assembly						
	1. 115V/230V	398305	89536	398305	1		
	2. 100V		89536		1		
2	Front Panel Assembly	398487	89536	398487	1		
3	Display PCB Assembly	398321	89536	398321	1		
4	Side Panel	363507	89536	363507	2		
5	Rear Panel	411793	89536	411793	1		
6	Prescaler PCB Assembly						
	1. 520 MHz (Standard)	396291	89536	396291	1		
	2. 1 GHz (Option-13)	396309	89536	396309	1		
	3. 1.25 GHz (Option-14)	405597	89536	405597	1		
7	Direct Preamp PCB Assembly	398347	89536	398347	1		
8	Push Rod Assembly	398453	89536	398453	1		
9	Bearing	376996	89536	376996	1		
10	Retaining Ring	355586					
11	Nut	364737	89536	364737	2		
12	Screw, 6-32 x 1/4, PHP	152140			4		
13	Screw, 4-40 x 1/4, PHP	129890			5		
14	Screw, 4-40 x 1/4, FHP	114884			3		
15	Screw, 4-40 x 1/4, THD	178590			2		
16	Screw, 6-32 x 3/16, FHP				4		
17	Washer, Internal Tooth, No. 4	110403			1		
18	Wire, Teflon, AWG No. 22, 2" Long, Green	115659			1		
19	Wire, Teflon, AWG No. 22, 2" Long, Black	115774			2		
20	Wire, Teflon, AWG No. 22, 2" Long, White	115667			2		
21	Final Assembly 1920A	400077	89536	400077	1		
22	Case Assembly 1920A						
	1. Standard Case Assembly	398438	89536	398438	1		
	2. Option-02 Case Assembly	398446	89536	398446	1		
23	Specification Decal	398225	89536	398225	1		
24	Screw, 6-20 x 5/8, Form "B"	156489			4		

Rev

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
25	BNC Connector	152033	13511	UG1094A/U			
26	AC Receptacle	284166	82389	EAC 301			
27	Ground Lug	167015	73734	118100	1		
	(Option-01 only)						
28	Battery PCB Assembly	398404	89536	398404	1		
29	Screw 6-32 x 1/4, PHP	152140			3		
	(Option-02 only)						
30	DOU PCB Assembly	398420	89536	398420	1		
31	Screw 6-32 x 1/4, PHP	152140			8		
32	Spacer, 6-32 x 1 1/2"	404285			4		
	(Option-06 only)						
33	Multiplier PCB Assembly	398388	89536	398388	1		
	NOTE: The following item is not illustrated						
34	Line Cord	343723			1		

Rev

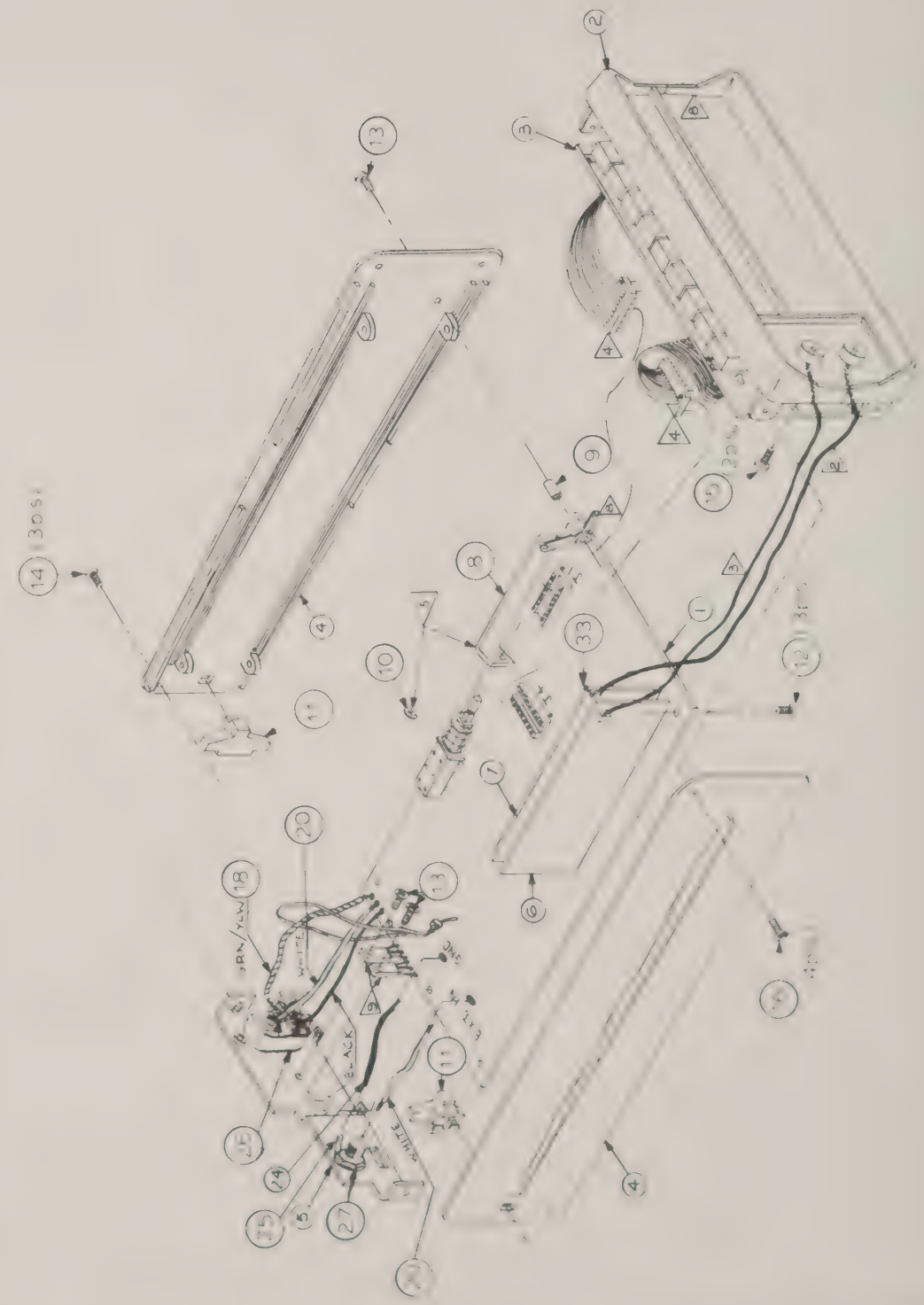

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Figure 5-1 Model 1920A Final Assembly (1 of 4)

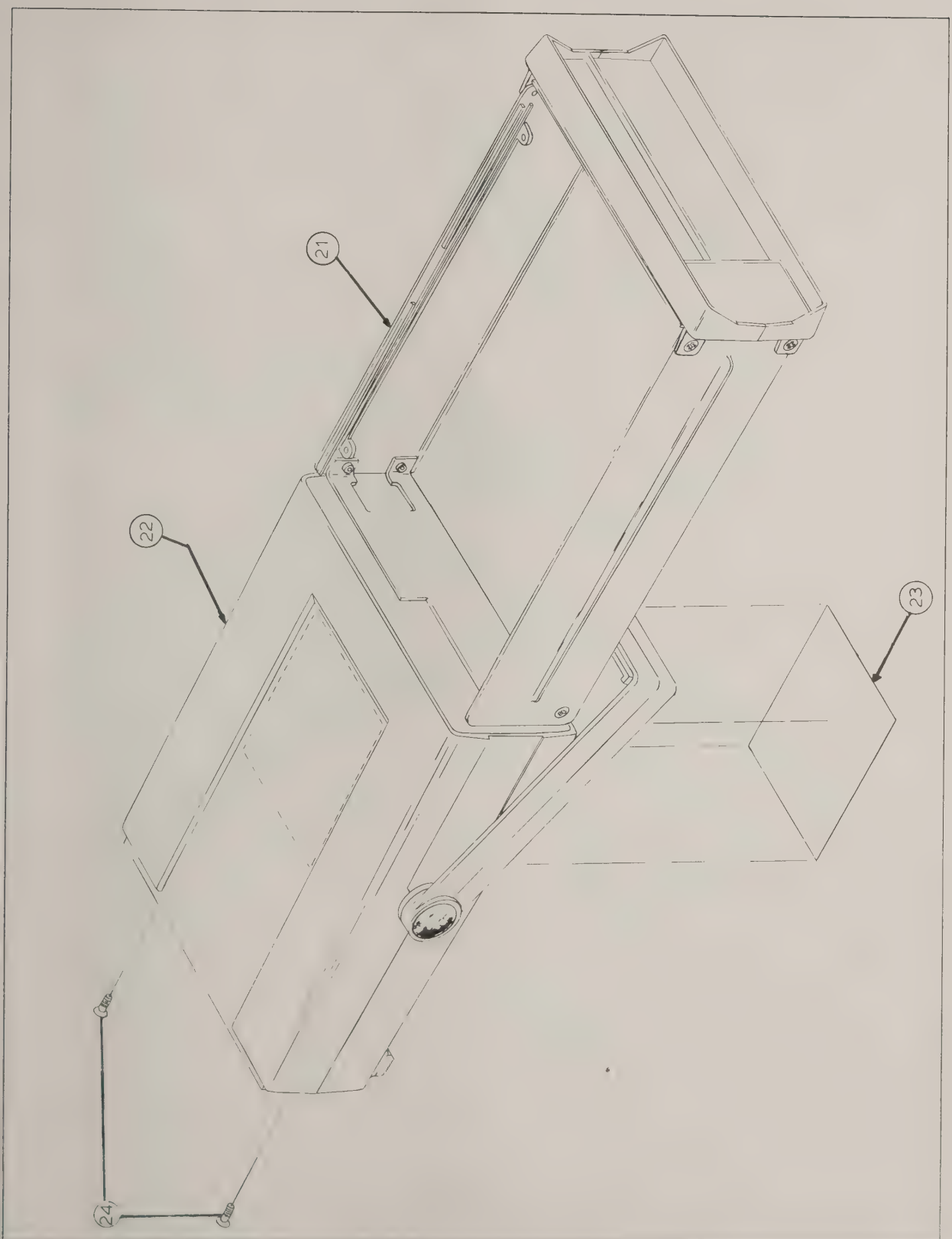

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Figure 1-1 Model 1920A Final Assembly (2 of 4)

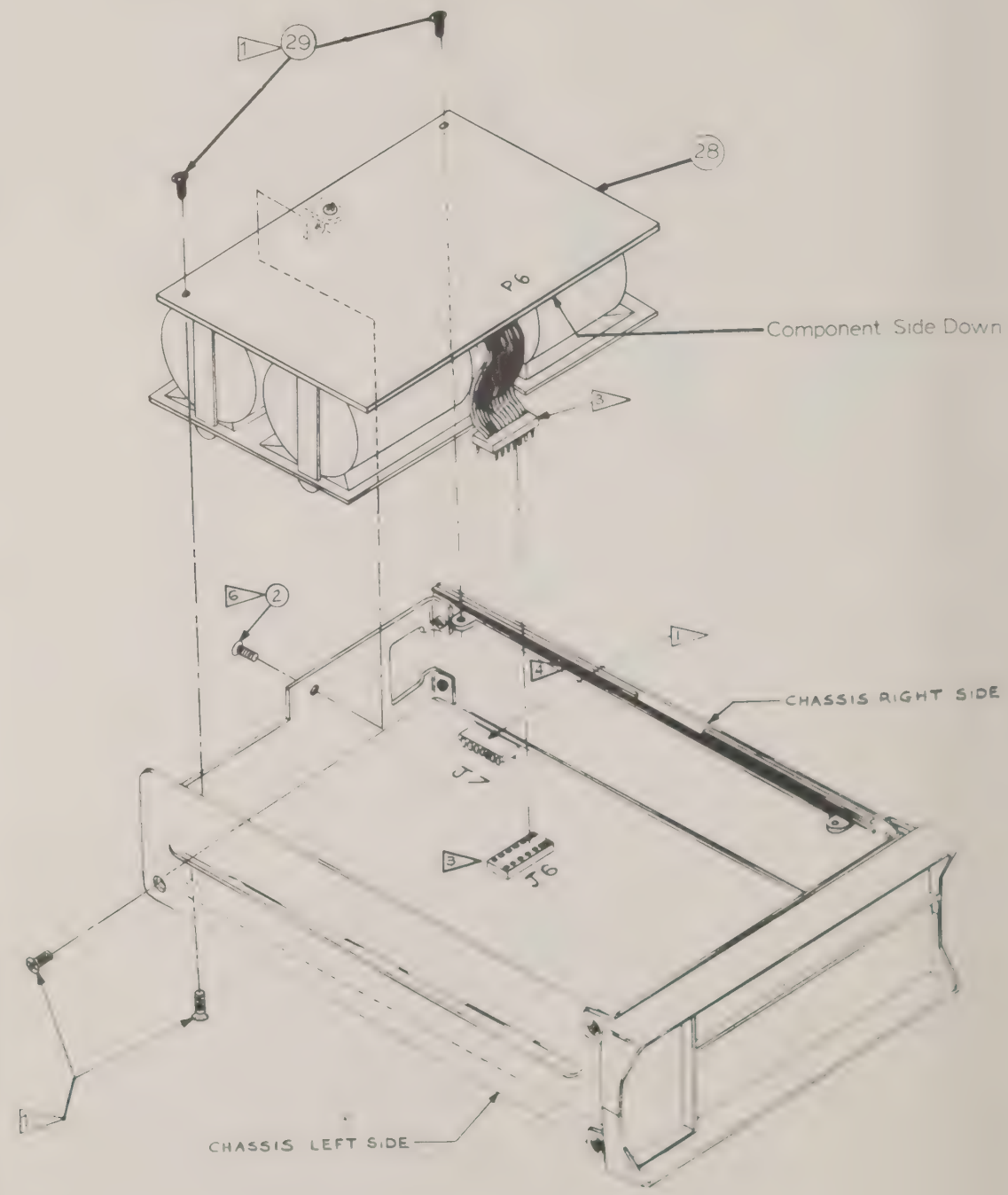

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Figure 5-1 Model 1920A Final Assembly (3 of 4)

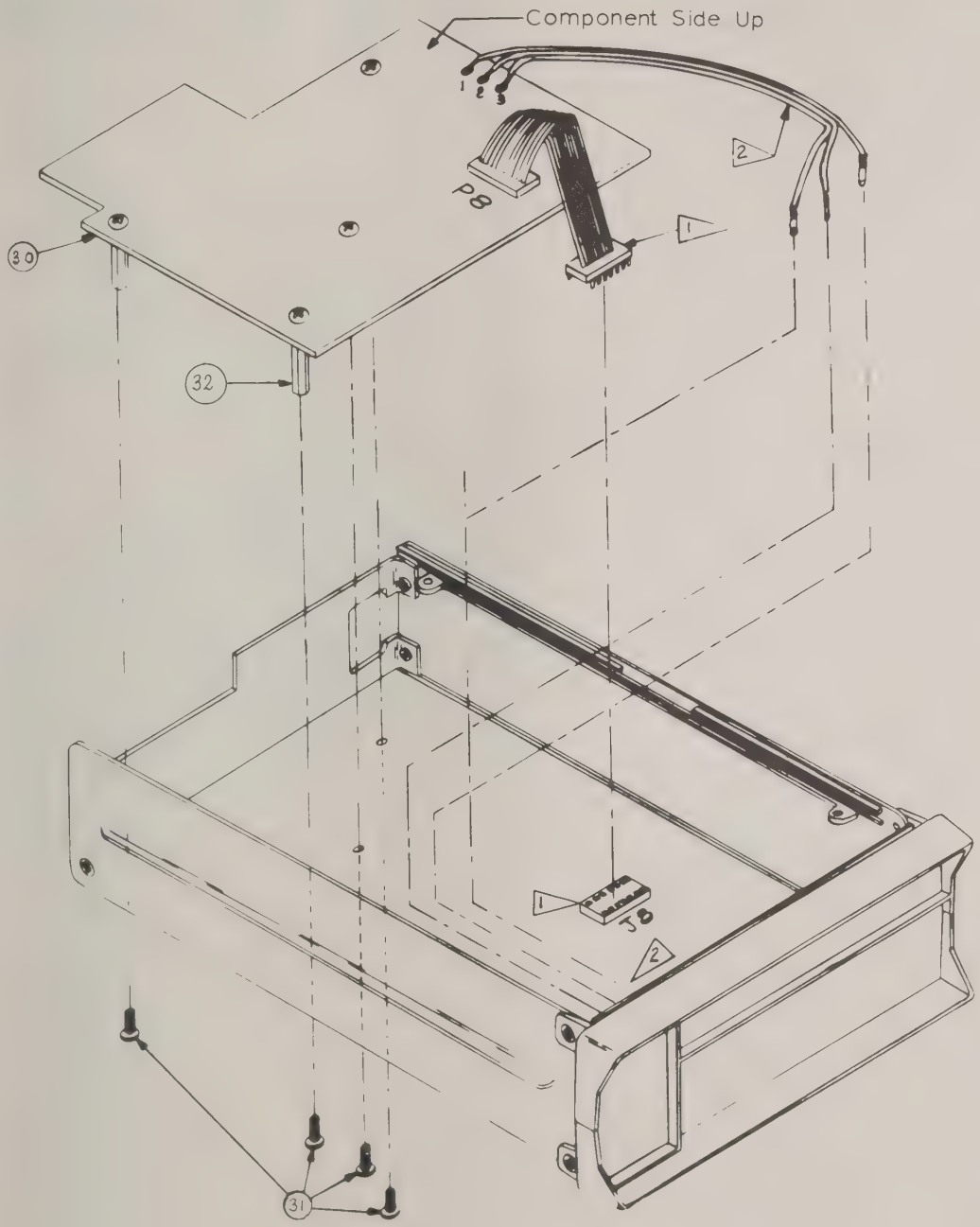

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Figure 5-1 Model 1920A Final Assembly (4 of 4)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	CASE ASSEMBLY 1920A Figure 5-2						
	1. Standard Case Assembly	398438	89536	398438	1		
	2. Option-02, Slotted Case Assembly	398446	89536	398446	1		
1	Case, 1920A						
	1. Standard Case	402214	89536	402214	1		
	2. Option-02, Slotted Case	402172	89536	402172			
2	Molded Handle	363648	89536	363648	1		
3	Washer, Square Hole	370171	89536	370171	2		
4	Spring Washer	228981	89536	228981	4		
5	Flat Washer	340505	89536	340505	2		
6	Screw, 6-20 x 3/8	288266			2		
7	Decal	416297	89536	416297	2		
8	Foot Pad	338632	89536	338632	2		

Rev

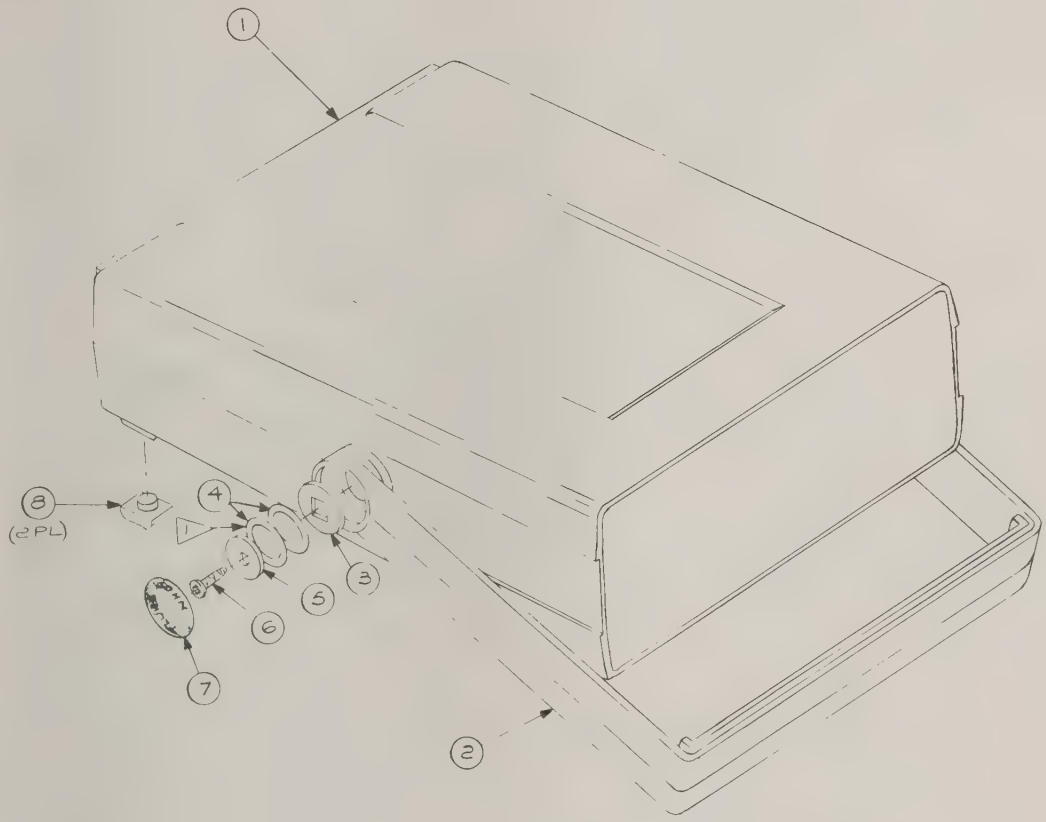

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Figure 5-2 Model 1920A Case Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	FRONT PANEL ASSEMBLY, 1920A, Figure 5-3	398487	89536	398487	1		
1	Front Panel	400119	89536	400119	1		
2	Input Decal	398230	89536	398230	1		
3	Front Panel	398248	89536	398248	1		
4	Actuator, Putty Gray	364711	89536	364711	10		
5	Actuator, Green	364729	89536	364729	1		
6	Slug	364745	89536	364745	11		
7	BNC Connector	152033	13511	UG1094A/U	1		
8	Plastic Lens	398263	89536	398263	1		
9	Cable Assembly	398461	89536	398461	1		
10	Ground Lug	167015	73734	118100	1		
11	Shielded Cable, 3 1/2" long	151993	70903	RG174/U	1		
12	Thermofit 1/8", 1/2" long	149450			2		
13	Switch Plug Decal NOTE: If option-06 is installed item 13 is replaced by one of item 4 and one of item 6.	408039	89536	408039			

Rev

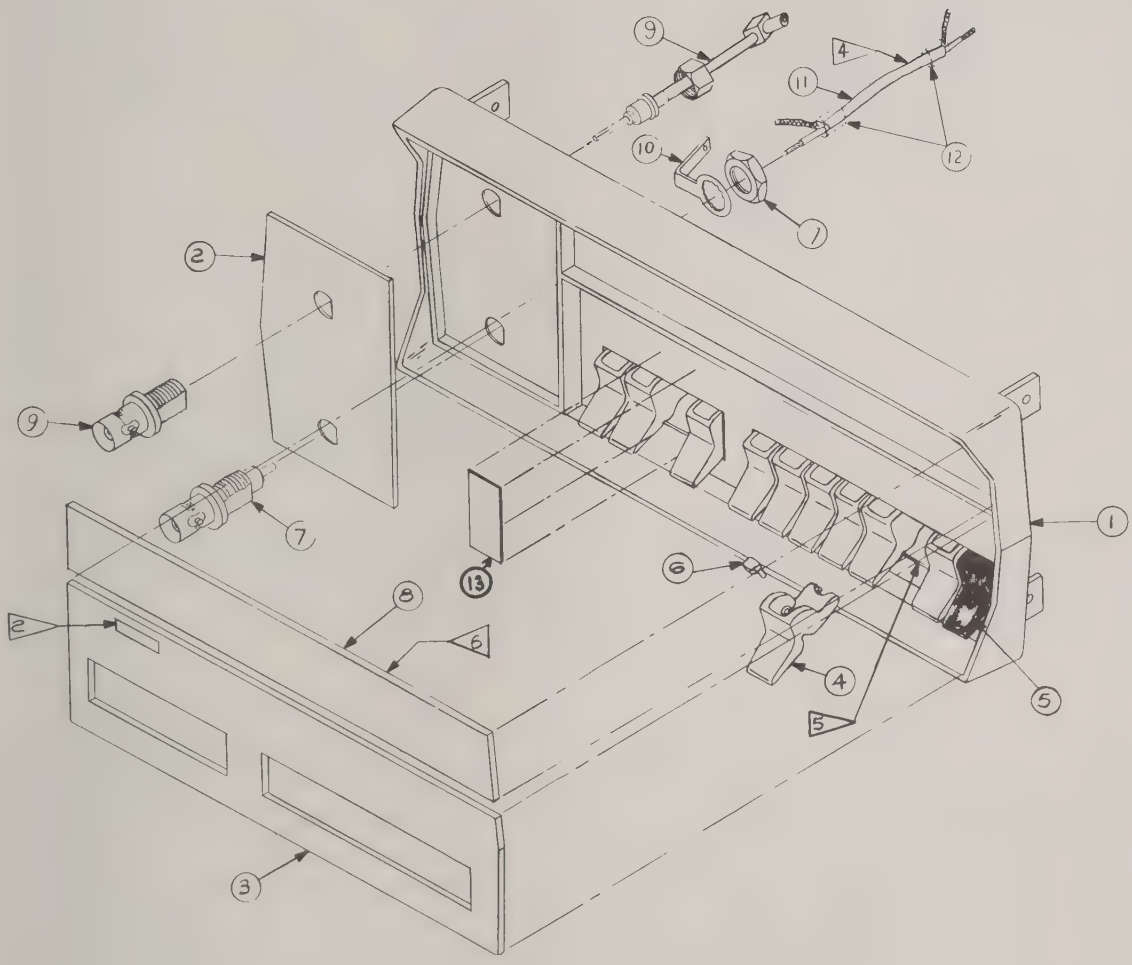

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Figure 5-3 Model 1920A Front Panel Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	DISPLAY PCB ASSEMBLY	398321	89536	398321	1		
	Figure 5-4						
DS1-DS6	Diode, Light-Emitting	385898	28480	5082-4887	6		
P1,P4	Flat Cable Assembly	393520			2		
P10	Amp Pin	376574	00779	5166-333-68	3		
Q1	Xtor, NPN, Si, LoP	369678	01295	T1S98	1		
R1,R3, R5	Res, 1/4W, 5%, CC, 330 ohms	147967	01121	CB	3		
R2	Res, 1/4W, 5%, CC, 1K	148023	01121	CB	1		
R4	Res, 1/4W, 5%, CC, 39 ohms	193391	01121	CB	1		
S1 - S11	Switch Assy	402164	89536	402164	1		
U1	IC, CMOS, Hex Buffer/Inverter	381848	95303	CD 4049AE	1		
U2	IC, CMOS, Quad 2 Input Pos NOR Gate	355172	95303	CD 4001AE	1		
U3 - U11	Display LED	380436	50579	DL-707-811	9		
1	Retaining Ring	355586			11		
2	Amp Pin	376574	00779	5166-333-68	3		
3	Spacer "Dogbone"	285346	71590	J64280	1		
4	Display PCB	395541	89536	395541	1		

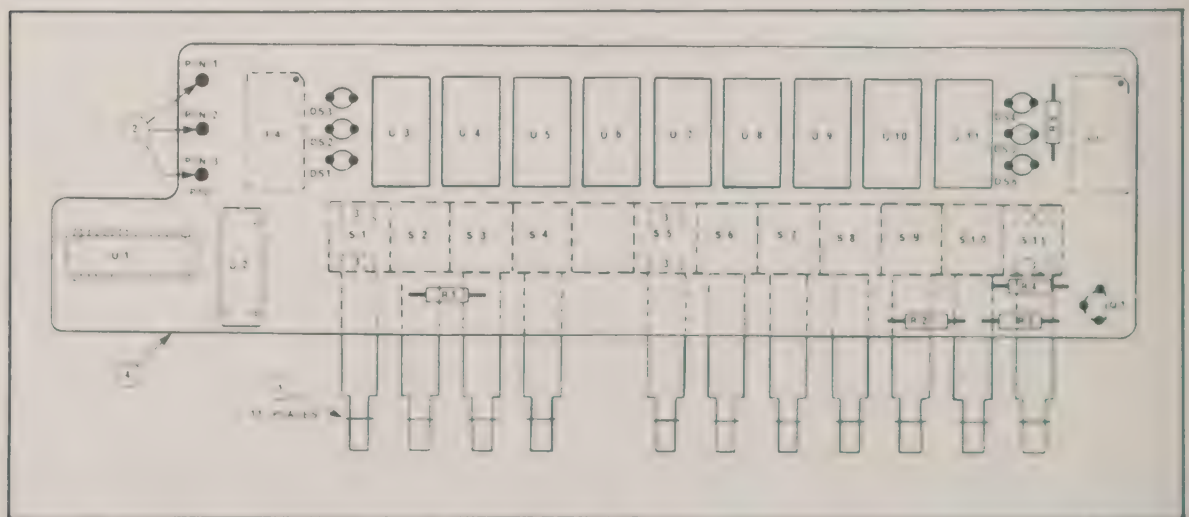


Figure 5-4 Display PCB Assembly

Rev

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	MAIN PCB ASSEMBLY 115/230 V		89536		1		
	Figure 5-5 or 100 V		89536		1		
C1,C12	Cap, Elect, 4700 uF, 10%, 10 V	379370	99392	39CS15HL53	2		
C2	Cap, Elect, 470 uF, 40 V	403030	mallory	TCW47IN040J1F1P	1		
C3	Cap, Elect, 100 uF, 40 V	236919	73445	ET101X040A6	1		
C4, C11	Cap, Tant, 10 uF, 20%, 16 V	193623	56289	19D106X0015JA1	2		
C5,19	Cap, .01 uF,	407361	centra-lab		2		
C6-C10 C13, C16, C17,	Cap, Cer, .01 uF, +80%/-20%, 25 V	335786	32897	5835-000Y5U103Z	8		
C21, C22, C24, C25	Cap, Ta, 10 uF, 20%, 35 V	0245	56289				
C14, C18, C20, C26, C27	Cap, Cer, .001 uF, 10%, 500 V	357806	71590	CF-102	5		
C15	Cap, Cer, 220 pF	309849	71590	CW30C224K	1		
C23	Cap, Cer, 10 pF, 10%, 3 KV	105536	56289	40C362A1	1		
CR1, CR2	Diode Bridge, Full Wave, 100 V, 2A	296509	14936	KBP02	2		
CR3-CR7	Diode, Ultra Fast Switch, Si	364224	07263	IN914	5		
CR8	Diode, Voltage Reg, Si	180497	07263	IN753	1		
F1	Fuse, 1/4 Amp, Slow MDL 1/4 A	166306	71400	MDL	1		
J4-J8, 1	16 Pin Socket, L.P.	370312	01295	C931602	10		
P7	Shorting Plug	413039	89536	413039	1		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q1, Q3, Q4, Q5	Xtor, PNP, Hi Speed Sat. Sw.	369629	07263	2N5771	4		
Q2, Q7, Q13-Q16 Q22-Q26	Xtor, PNP, Si	381780	01295	TCS103	11		
Q6, Q28	Xtor, PNP, Sm Sig Amp, T092-1	369652		SX4061	2		
Q8-Q12 Q17-Q21, Q27	Xtor, NPN, Sm Sig Amp,	369678		TIS98	11		
R1	Res, 1W, 10%, CC, 100 ohms	109363	01121	GB			
R2,R3, R4,	Res, 1/4W, 5%, CC, 22K	148130	01121	CB	3		
R5, R11, R29	Res, 1/4W, 5%, CC, 10K	148106	01121	CB	3		
R6, R27	Res, 1/4W, 5%, CC, 4.7K	148072	01121	CB	2		
R7,89, R16, R20, R32	Res, 1/4W, 5%, CC, 220 ohms	147959	01121	CB	5		
[illegible] R21 [illegible]	Res, 1/4W, 5%, CC, 1K	148023	01121	CB	11		

Rev

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R10, R44	Res, 1/4W, 5%, CC, 100 ohms	147926	01121	CB	2		
R12, R13	Res, 1/4W, 5%, CC, 1 Meg.	182204	01121	CB	2		
R14, R18, R19, R43	Res, 1/4W, 5%, CC, 100K	148189	01121	CB	4		
R15, R33	Res, 1/4W, 5%, CC, 2.7K	170720	01121	CB	2		
R17, R38	Res, 1/4W, 5%, CC, 3.3K	148155	01121	CB	2		
R22	Res, 1/4W, 5%, CC, 1.2K	190371	01121	CB	1		
R23	Res, 1/4W, 5%, CC, 330K	192948	1121	CB	1		
R30, R41	Res, 1/4W, 5%, CC, 270 ohms	160804	01121	CB	2		
R34	Res, 1/4W, 5%, CC, 2.2K	148049	01121	CB	1		
R37, R39, R42	Res, 1/4W, 5%, CC, 180 ohms	147942	01121	CB	3		
R40	Res, 1/4W, 5%, CC, 33 ohms	175034	01121	CB	1		
S1	Power Switch	403618	centro-lab	PB1	1		
S2	Switch, 115V/230V, DPDT, Slide Note: S2 is not installed on 100V version	376798	Switch-	11A-1437	1		
S3	Slide Switch	404814	79727	G1-52-DPDT	1		
T1	Power Transformer 115/230V or 100V	402206	89536	402206	1		
U1	IC, CMOS, Quad 2 Input Pos NOR Gate	355172	95303	CD4001AE	1		
U2	IC, CMOS, Decade Counter/Decoder	403568	95303	CD4017AE	1		
U3	IC, CMOS, Hex Buffer/Inverter	381848	95303	CD4049AE	1		
U4	IC, MOS, Programmable Divider	381822	MOSTEK	MK5009	1		
U5, U30	IC, CMOS, Hex Buffer/Converter	381830	95303	CD4050AE	2		
U6,U8	IC. CMOS, Dual D Flip Flop	340117	95303	CD4013AE	2		
U7	IC, CMOS, Dual 4 Input Pos NOR Gate	363820	95303	CD4002AE	1		
U9	IC, CMOS, Triple 3 Input NAND Gate	375147	95303	CD4023AE	1		
U10	IC, TTL, Quad 2 Input Pos NOR Gate	288845	01295	SN7402	1		

Rev

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U11	IC, Lin., 3 Term Volt. Reg; 18 V, TO-220, uA 7818	402768	07263	7818UC	1		
U12	IC, Lin., 3 Term Volt Reg. 5 V, TO-220, uA7805	355107	07263	7805UC	1		
U13, U22	IC, Lin., 3 Term Volt Reg. 12 V TO-92, 78L12AC	408138	07263	78L12AWC	2		
U14	IC, Lin Differential Comparator	343343	07263	uA710DM	1		
U15, U24	IC, TTL, Decade Ctr.	293159	01295	SN7490	2		
U16	IC, TTL, Quad 2 to 1 line Data Multiplexer, 74157 or 9322	403576	01295	SN74157N	1		
U17	IC, TTL, Binary Ctr.	320739	01295	SN7493	1		
U18	IC, Lin, Freq-Comp Op Amp	402750	07263	uA741DM	1		
U19	IC, Lin, Timer, 555	402610	Signet-ics	NE555V	1		
U20	IC, ECL, Triple 4-3-3 Input NOR Gate	402735	07263	F95106	1		
U21	IC, ECL, Edge Triggered JK Flip Flop	402743	07263	F95029	1		
U23	IC, TTL, Quad 2 Input Pos NAND Gate	292953	01295	SN7400N	1		
U25	IC, TTL, Quad 2 Input Pos NOR Gate	403626	01295	SN74S02	1		
U26, U27	IC, TTL, Schottky Dual Edge Triggered JK Flip Flop	363440	01295	SN74S112	2		
U28	IC, LSI, MOS, 1 MHz, 7 Digit Decade Ctr, 40 Pins	380238	89536	1801A	1		
U29	IC, TTL, BCD to 7 Segment Decoder/Driver	340109	01295	SN7447	1		
R1	IC, DIP Resistor, 7 at 39 ohms, (Replaceable by 7@39 ohm Resistors, P/N 193391)	413866	11236	760	1		
XU	TCXO-03	369751	89536	369751	1		
XU	TCXO-04 (Optional)	369769	89536	369769	1		
F	Fuse Clip	284984	Fuse [illegible]	3621-2	1		
-	40 Pin Socket, L.P.	376224			1		
-	Guide Pin	375840	89536	375840	1		
-	Amp Pin	376574	00779	5166-333-68	14		
-	14 Pin Socket, L.P.	291542	00779	583527-1	1		
-	Spacer, "Dogbone"	285346	71590	J64280	1		
-	Main PCB	395525	89536	395525	1		

Rev

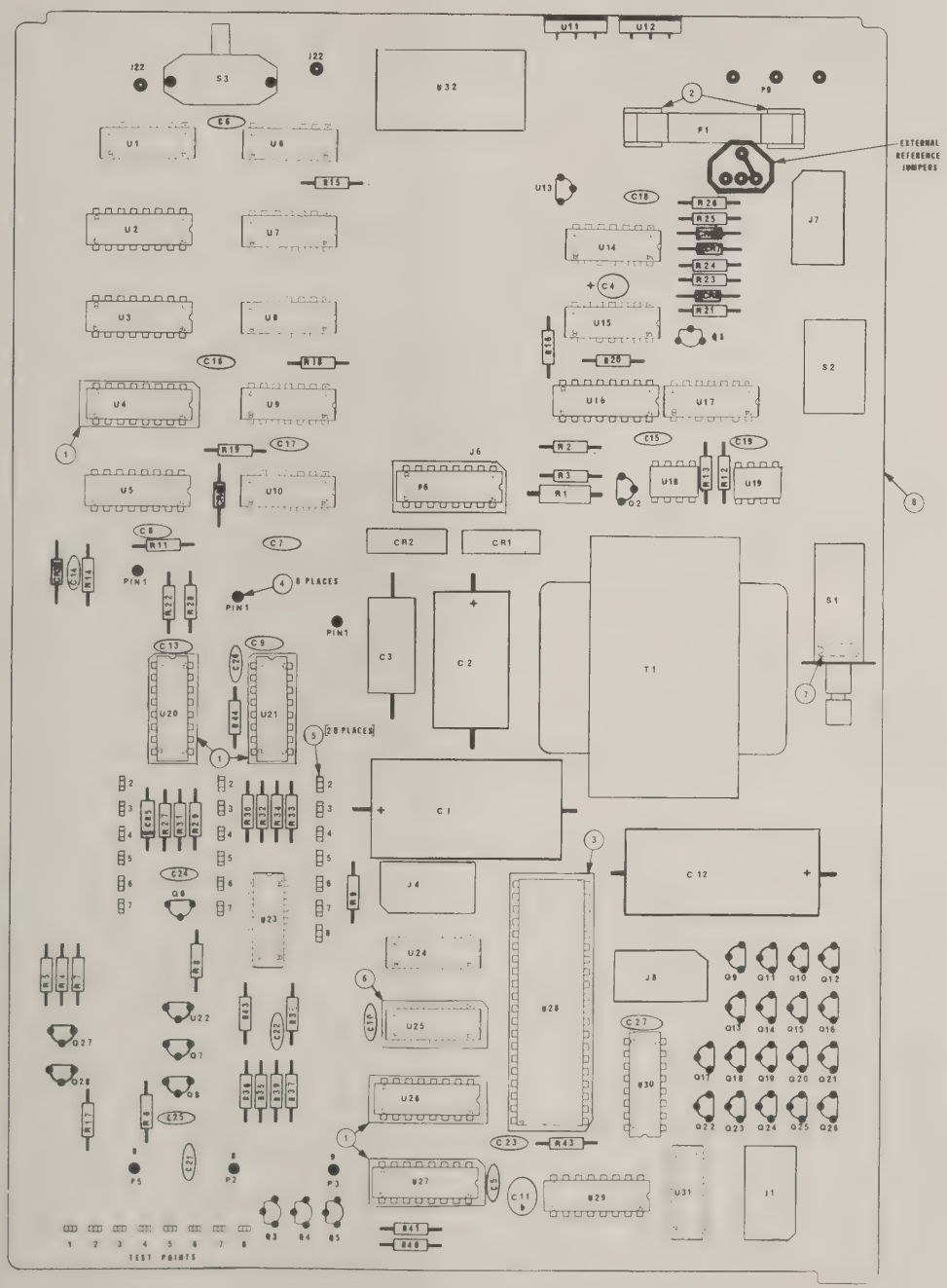


Figure 5-5 Main PCB Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	520 MHz PRESCALER PCB ASSEMBLY Figure 5-6	396184	89536	396184			
C1, C2, C4, C6, C9	Cap. .001 uf	402966	71590		5		
C3, C7, C11, C12	Cap. .001 uf,/500V Fixed, Cer. Disc., 10%, 1000 pf	357806	71590	CF102	4		
C5, C10	Cap. .01 uf	407361	71590		2		
C8	Cap. 22 pf. Ceramic Disc., Fixed, Cer. Disc	369157	72982	10TCC-Q22	1		
CR6, CR7	Diode HP5082-2835	369595	28480	HP5082-2835	2		
CR3, CR4, CR5	Diode HP5082-3379	402776	28480	HP5082-3379			
CR8	Diode, 1N914, Switching, LoP, Si	364224	07263	1N914	1		
CR9	Diode, 1N751, Zener, Si	159798	07263	1N751	1		
F1, F2	Fuse, .2 Amp., 2.6 ohm, Maxcold	370557	75915	273.200	2		
J20	Coax Connector Snp-on, PCB Mount, Right Angle, Con-hex Type	353243	98291	51-053-000	1		
Q1, Q5	Transistor, T1S98, NPN Si, LoP	369678	01295	T1S98	2		
Q2	Transistor, TCS103, Sm Sig, PNP, Si, TO-92	381780	01295	TCS103	1		
Q3	Transistor 2N4274, NPN, Si, LoP	369645	07263	2N4274	1		
R1, R10	[illegible], 1/4W, 5%, 82 ohms, C.C.	149484	[illegible]	[illegible]	2		
R2	[illegible], 1/4W, 5%, 22 ohms, C.C.	147884	[illegible]	[illegible]	1		
R3, R4, R8	[illegible], 1/4W, 5%, 470 ohms, C.C.	147983	[illegible]	[illegible]	3		
R4	[illegible], 1/4W, 5%, 680 ohms, C.C.	148007	[illegible]	[illegible]	1		
R5, R11, R21	[illegible], 1/4W, 5%, 1K, C.C.	148023	[illegible]	[illegible]	3		

Rev A

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R7, R12, R10, R13	Res., 1/4W, 5%, 2.7K, C.C.	170720	01121	CB	4		
R8	Res., 1/4W, 5%, 68 ohms, C.C.	147918	01121	CB	1		
R9, R15, R20	Res., 1/4W, 5%, 10K, C.C.	148106	01121	CB	3		
R16	Trimpot 10K, Var R, 20% 2 Meg., 30% 2.2 Meg	385393	Piher	PT10H10K	1		
R18	Res., 1/4W, 5%, 2.2M, C.C.	198390	01121	CB	1		
R19	Res., 1/4W, 5%, 330K, C.C.	192948	01121	CB	1		
U1	I.C. OM185	392977	Philips	OM185	1		
U2	I.C. GPD 402	402594	24539	GPD 402	1		
U3	I.C. 11C05	402719	07263	11C05	1		
U4	I.C. 741 Mini Dip, OP Amp	402750	07263	741TC	1		
1	Connector, Test Jack No. 105-0753	149112	74970	105-0753	2		
2	Amp Receptacle	375329	00779	85863-3	6		
3	Fuse Socket	403642	00779	50863-B	4		
4	520 MHz Prescaler PCB	396077	89536	396077	1		
5	14 Pin IC Socket L.P.	291542	00779	583527-1	1		

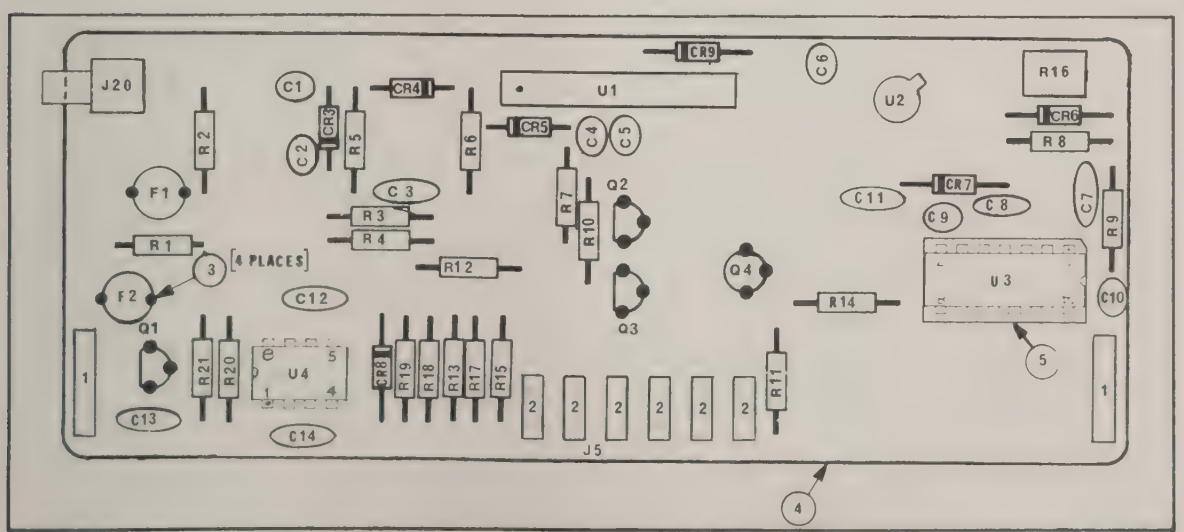


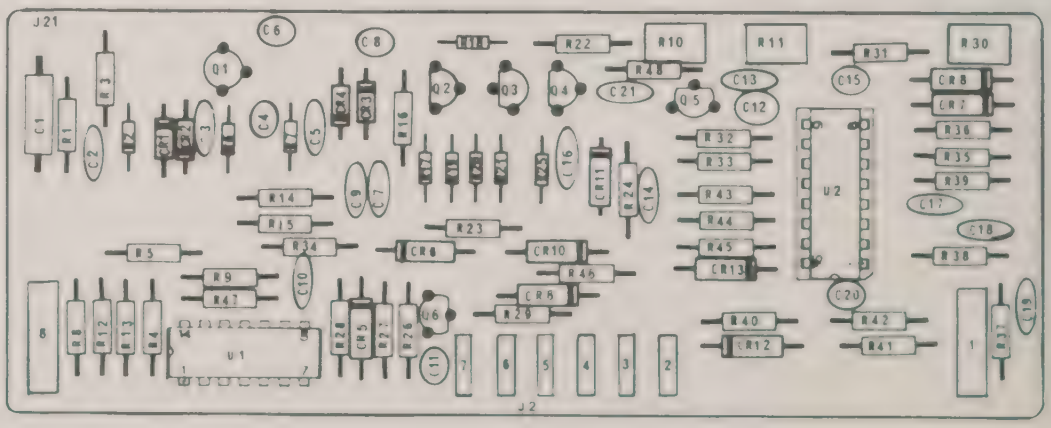
Figure 5-6 Prescaler PCB Assembly - 520 MHz

Rev A

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	DIRECT PREAMP PCB ASSEMBLY	398347	89536	398347			
	Figure 5-7						
C1	Cap, Mylar, 0.1 uF ±10%, 250 V	161992	73445	C280AE/A100K	1		
C2	Cap, Cer Disc, 47 pF, 20%, 1000 V	369132	56289	C030B102H470J	1		
C3	Cap, Cer Disc, 22 pF, 20%, 500 V	369157	72982	10TCC-Q22	2		
C5							
C4	Cap, Ta, 22 uF, 20%, 20 V	357780			3		
C8							
C12							
C6	Cap, Ta, 10 uF, 20%, 16 V	193623	56289	196D106X0015JA1	6		
C11							
C14							
C15							
C20							
C22							
C21	Cap, Cer Disc, 220 pF, 20%, 50 V	309849	71590	CW30C224K	1		
C7	Cap, Cer Disc, 0.01 uF,	368639			3		
C9							
C19							
C10	Cap, Cer Disc, 0.001 uF, 10% 500 V	357806	71590	CF102	3		
C13							
C16							
C17	Cap, Mini, Plate, 100 pF, 2%, 100 V	369173			2		
C18							
CR1	Diode, Ultra fast, Low Cap, Si	381806	07263	IN3062	4		
CR2							
CR10							
CR12							
CR3	Diode, Pin, HP 5082-3379	402776	28480	HP 5082-3379	3		
CR4							
CR11							
CR5	Diode, IN914, Switching, LoP, Si	364224	07263	IN914	2		
CR6							
CR7	Diode, Hot Carrier	369595	07263	FH1100	3		
CR8							
CR9							
CR13	Diode, Zener 3.3 V, 5%	309799	07263	IN7464	1		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q1	Xtor, FET, H.F. Sm Sig	403634	17856	E310	1		
Q2	Xtor, H.F.		PHILIPS	BF357	2		
Q4							
Q3	Xtor, 2N5771, Si, PNP	369629	07263	2N5771			
Q5	Xtor, FET, N-Chl	272120	04713	2N5555	2		
Q6							
R1	Res, 1/4W, 5%, CC, 120 K	193458	01121	CB	1		
R3	Res, 1/4W, 5%, CC, 1 M	182204	01121	CB	4		
R16							
R24							
R26							
R4	Res, 1/4W, 5%, CC, 10 K	148106	01121	CB	8		
R5							
R8							
R9							
R12							
R13							
R29							
R47							
R14	Res, 1/4W, 5%, CC, 4.7 K	148072	01121	CB	2		
R15							
R22	Res, 1/4W, 5%, CC, 10 ohms	147868	01121	CB	2		
R23							
R27	Res, 1/4W, 5%, CC, 180 K	193441	01121	CB	1		
R28	Res, 1/4W, 5%, CC, 82 K	188458	01121	CB	1		
R31	Res, 1/4W, 5%, CC, 56 K	170738	01121	CB	1		
R32	Res, 1/4W, 5%, CC, 2.2 K	148049	01121	CB	4		
R33							
R34							
R37							
R35	Res, 1/4W, 5%, CC, 560	147991	01121	CB	6		
R36							
R43							
R44							
R45							
R46							
R38	Res, 1/4W, 5%, CC, 270	160804	01121	CB	2		
R39							

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R40	Res, 1/4W, 5%, CC, 1 K	148023	01121	CB	1		
R10	Res, Trimpot, 10 K	385393	PIHER	PT-10H-10K	3		
R11							
R30							
R41	Res, 1/4W, 5%, CC, 470	147983	01121	CB	2		
R42							
R2	Res, 1/8W, 10%, CC, 100	261826			2		
R20							
R6	Res, 1/8W, 10%, CC, 220				1		
R7	Res, 1/8W, 10%, CC, 2.2 K	153965			1		
R17	Res, 1/8W, 10%, CC, 68 K				1		
R18	Res, 1/8W, 10%, CC, 560	115303			1		
R19	Res, 1/8W, 10%, CC, 10 K	246975			1		
R21	Res, 1/8W, 10%, CC, 1.2 K				1		
R25	Res, 1/8W, 10%, CC, 1 K	153916			1		
R48	Res, 1/4W, 5%, CC, 47	147892			1		
U1	IC, Quadruple Op Amp, DIP, 14 Pin			LM324 or MC3403	1		
U2	IC, Triple-Line Receiver, DIP, 16 Pin	402727	07263	F95116	1		
1	1920A-3004 Direct Preamp PCB	395558	89536		1		
2	1920A-8015 Shield		89536		1		
3	Bus Wire # 16 X 0.5"	135699	89536		2		
4	Test Jack, Connector # 105-0753	149112	74970		2		
5	Amp Receptacle	375329	00779	85863-3	6		
6	Socket, I.C., Low Profile, DIP 16 Pin	370312	01295	C931602	1		



Rev

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	MULTIPLIER PCB ASSEMBLY Figure 5-8	398388	89536	398388	1		
C1,C3 C6,C8	Cap, Ta, 10 uF, 20%, 16 V	193623	56289	196D106X0015	4		
C2,C5	Cap, Cer, 0.1 uF, 25 V	369199	71590	UK - 25 - 104	2		
C4	Cap, Cer, 22 pF, 20%, 10 K	369157	72982	10TCC-Q22	1		
C7	Cap, Cer Disc, .001 uF, 10%, 500 V	357806	71590	CF-102	1		
CR1, CR2	Diode, Ultrafast Switch, Si	364224	07263	IN914	2		
Q1	Xtor, FET, P-Chl, Amp	403600	07263	2N4342	1		
Q2,Q6 Q7	Xtor, NPN, Sm Sig, Switching	369645	07263	2N4274	3		
Q3	Xtor, Dual FET, N-Chl, Hi GFS	379271	17856	E421	1		
Q4,Q5	Xtor, PNP, Hi Speed Switch	369629	07263	2N5771	2		
Q8,Q9	Xtor, NPN, Sm Sig Amp, Low Noise	369678		TIS98	2		
Q10	Xtor, PNP, Si	381780	01295	TCS103	1		
R1,R2 R18	Res, 1/4W, 5%, CC, 2.7 K	170720	01121	CB	3		
R3,R6 R7, R14, R22, R25	Res, 1/4W, 5%, CC, 1 K	148023	01121	CB	6		
R4	Res, 1/4W, 5%, CC, 22 K	148130	01121	CB	1		
R5,	Res, 1/4W, 5%, CC, 560 ohms	147991	01121	CB	1		
R11	Res, 1/4W, 5%, CC, 390 ohms	147975	01121	CB	1		
R8	Res, 1/4W, 5%, CC, 1 Meg	182204	01121	CB	1		
R9	Res, 1/4W, 5%, CC, 470 K	188441	01121	CB	1		
R10	Res, 1/4W, 5%, CC, 180 ohms	147942	01121	CB	1		
R12	Res, 1/4W, 5%, CC, 150 ohms	147934	01121	CB	1		
R17	Res, 1/4W, 5%, CC, 220 ohms	147959	01121	CB	1		
R13	Res, 1/4W, 5%, CC, 820 ohms	148015	01121	CB	1		
R15	Res, 1/4W, 5%, CC, 1.2 K	190371	01121	CB	1		
R16	Res, 1/4W, 5%, CC, 390 ohms	147975	01121	CB	1		
R19	Res, 1/4W, 5%, CC, 3.3 K	148056	01121	CB	1		
R20	Res, 1/4W, 5%, CC, 100 K	148189	01121	CB	1		
R21	Res, 1/4W, 5%, CC, 27 K	148148	01121	CB	1		
R23, R24	Res, 1/4W, 5%, CC, 4.7 K	148072	01121	CB	2		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U1,U2	IC, TTL, Decade Counter	293159	07263	7490	2		
U3	IC, CMOS, Phase Locked Loop	403584	95303	CD4046AE	1		
U4	IC, TTL, Decade Counter	320754	07263	74196	1		
U5	IC, TTL, Hex Buffer/Driver	288605	07263	7416	1		
U6	IC, 3 Terminal Voltage Reg. 12V	408138	07263	78L12	1		
1	Connector, Test Jack	149112	74970	105-0753	2		
2	Amp Receptacle	375329	00779	35863-3	7		
3	Multiplier PCB	395574	89536	395574	1		

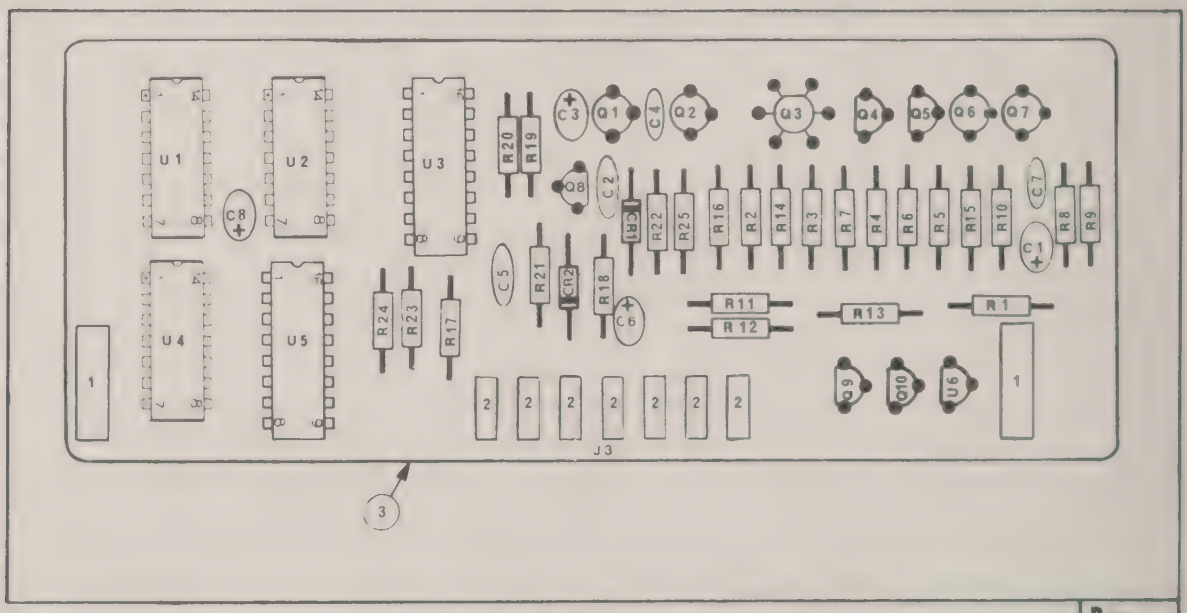


Figure 5-8 Multiplier PCB Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	BATTERY PCB ASSEMBLY Figure 5-10	398404	89536	398404			
BT1- BT4	Battery, NICAD	346924	17338	41B004AD15GL	4		
C1, C2	Cap. Tantalum, 10 uF, 20%, 16 V	193623	56289	196D106X0015JA1	2		
C3,	Cap. Ceram Disc, 0.01 uF, 50 V	369579			1		
C4	Cap., Ta, 10 uF, 20%, 35 V	0245	56289		1		
C5	Cap., Ceram., 0.1 uF, 25 V	369199	71590	UK - 25 - 104	1		
C6	Cap., Ceram Disc, 47 pF, 20%, 1000 V	369132	56289	C030B102H470J	1		
CR1	Diode, Rectifier	343491	07163	IN4002	1		
CR2	Diode, Zener, 7.5 V, 5%	256446	07263	IN755A	1		
CR3	Diode, Zener, 3.3 V, 5%	309799	07263	IN746A	1		
CR4,	Diode, Ultra Fast Sw, Si	364224	07263	IN914	9		
F1	Fuse, 3 Amp, MDL Slow		71400	MDL	1		
L1	Inductor, 6 Turn	320911	89536	320911	1		
P6	Flat Cable Assy	393520			1		
Q1, Q2, Q5	Xtor, NPN, Si, Power, 2N5190, TO-220-00	407353	04713	2N5190	3		
Q3, Q4, Q6, Q8	Xtor, NPN, Si, LoP	369678	-1295	TIS98	4		
Q7	Xtor, PNP, Sm Sig Amp, TO92-1	369652	01295	SX4061	1		
R1, R2	Res, 1/4W, 5%, CC, 2.2 K	148049	01121	CB	2		
R3, R4, R9	Res, 1/4W, 5%, CC, 27 K	148148	01121	CB	3		
R5	Res, 1W, 5%, CC, 0.1 ohm	404293	IRC	BWH	1		
R6	Res, Trimpot, 10 K	369553	Piher	PF-10V-10K	1		
R7	Res, 1/4W, 5%, CC, 180 K	193441	01121	CB	1		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R8, R14, R15	Res, 1/4W, 5%, CC, 10 K	148106	01121	CB	3		
R10	Res, 1/4W, 5%, CC, 47 K	148163	01121	CB	1		
R11	Res, 1/4W, 5%, CC, 10 ohms	147868	01121	CB	1		
R12	Res, 1/4W, 5%, CC, 330 ohms	147967	01121	CB	1		
R13	Res, 1/4W, 5%, CC, 82 ohms	149484	01121	CB	1		
T1	Transformer, Inverter	402198	89536	402198	1		
U1	IC, Lin., Freq Comp. Op Amp	402750	07263	uA741DM	1		
1	Screw, 6-32 x 1.56, PHP	347427			2		
2	Nut, Hex, 6-32	110551			2		
3	Screw, 4-40 x 3/8 PHP	152124			3		
4	Nut, Hex, 4-40	110635			3		
5	Lockwasher, No. 4	110403			3		
6	Bracket				1		
7	Insulating washer				1		
8	Fuse Clips	284984	Fuse Indicator Corp.	3621-2	2		
9	Battery Holder	346932	89536	346932	4		
10	Battery Contact	344200	89536	344200	8		
11	Battery PCB	398271	89536	398271			

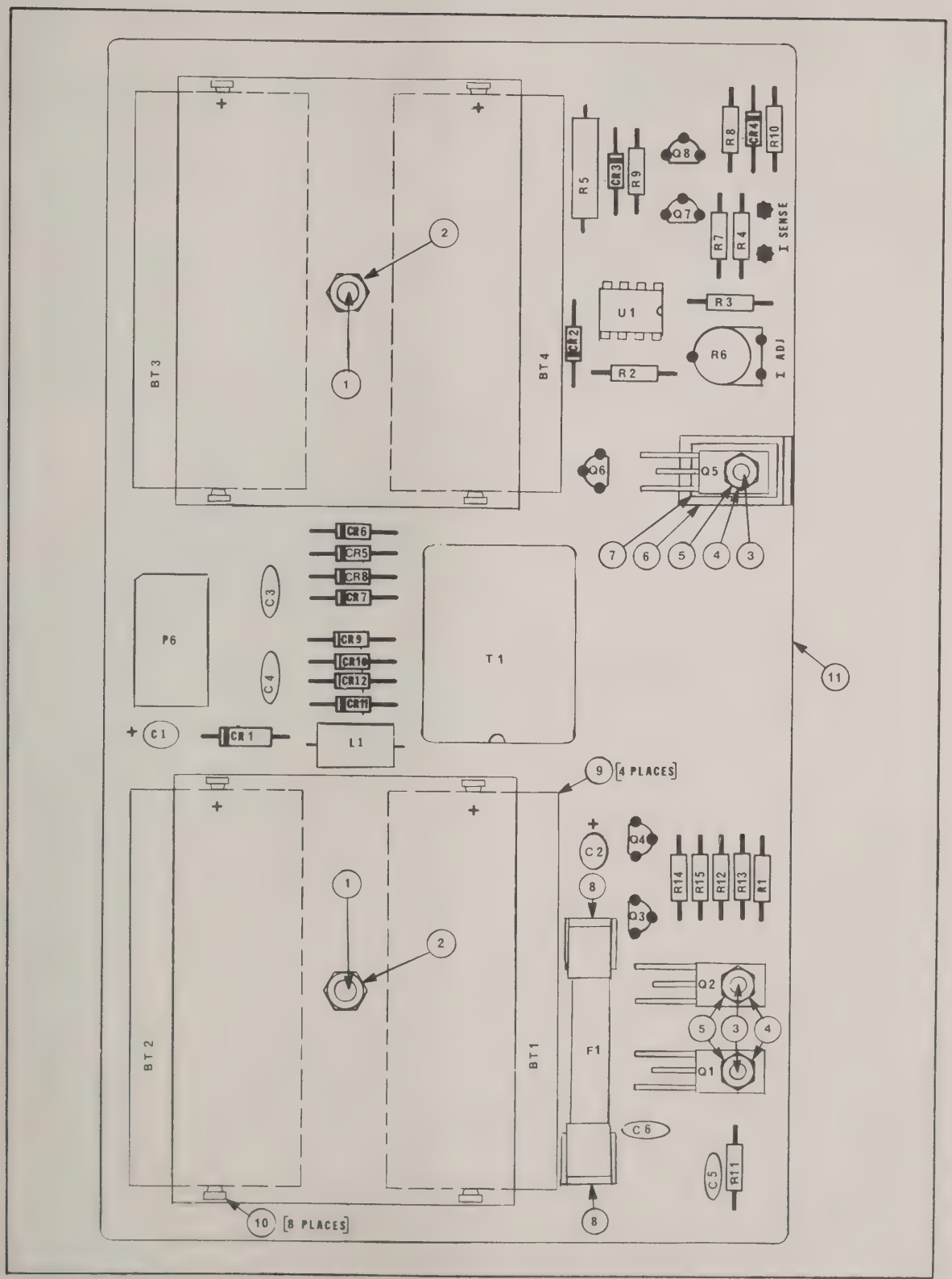


Figure 5-9 Battery PCB Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	DOU PCB ASSEMBLY	398420	89536	398420			
	Figure 5-10						
C1, C3	Cap., Tantalum, 10 uF, 20%, 16 V	193623	56289	196D106X0015JA	2		
C2	Cap., Ceram., 0.001 uF, 10%, 500 V	357806	71590	CF-102	1		
P8	Flat Cable Assembly	393520					
R1	Res, 1/4W, 5%, CC, 47 K	148163	01121	CB	1		
R2	Res. 1/4W, 5%, CC, 10 K	148189	01121	CB	1		
U1, U7	IC, CMOS, Quad 2 Input Pos NAND Gate	355198	95303	CD4011AE	2		
U2	IC, CMOS, Dual Monostable Multivibrator	393512	04713	MC 14528	1		
U3-U6, U8-U13	IC, CMOS, Quad Clocked D Latch	355149	95303	CD4042AE	10		
1	3 Wire Cable, 12" long. No. 263 wire	229682			1		
2	Amp Pin Receptacle	267542	00779	85896-3-C	3		
3	Thermofit, 1/8" x 3/4" long	149450			3		
4	DOU PCB	398289	89536	398289	1		

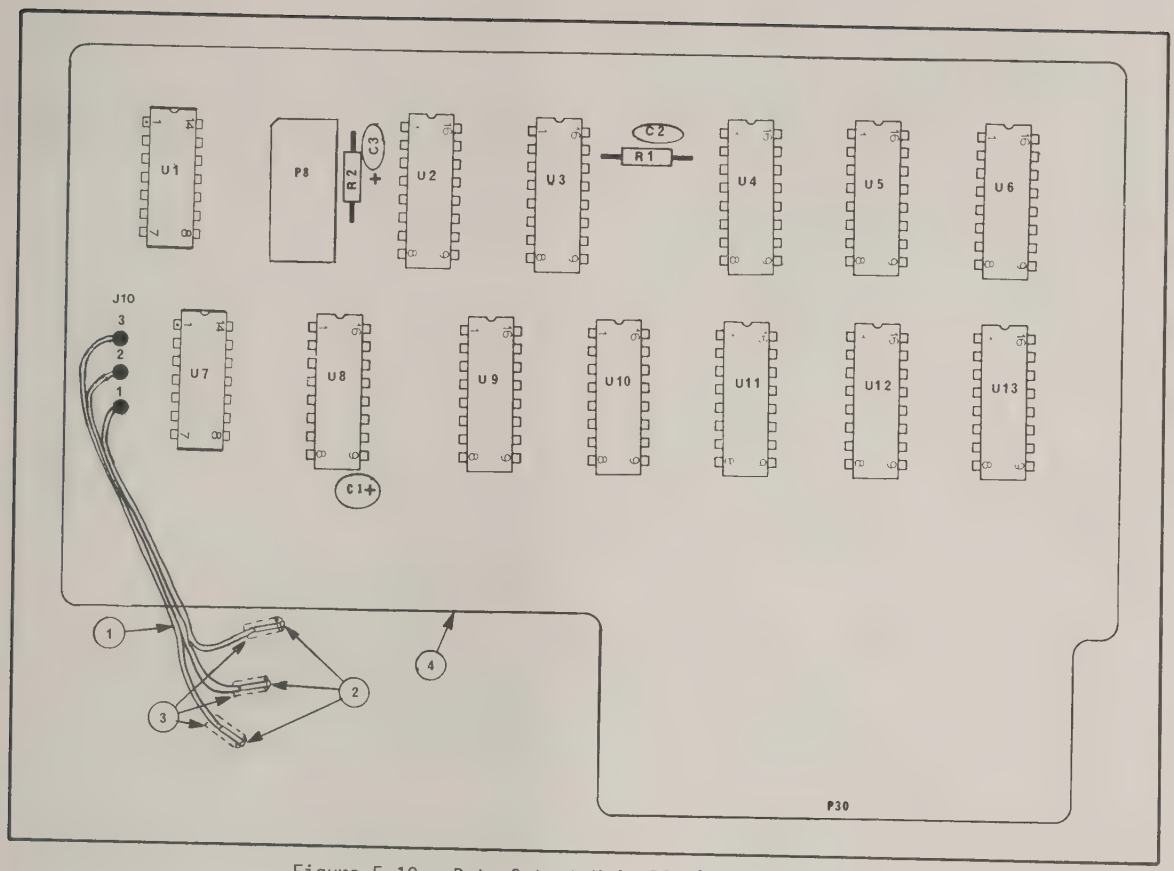
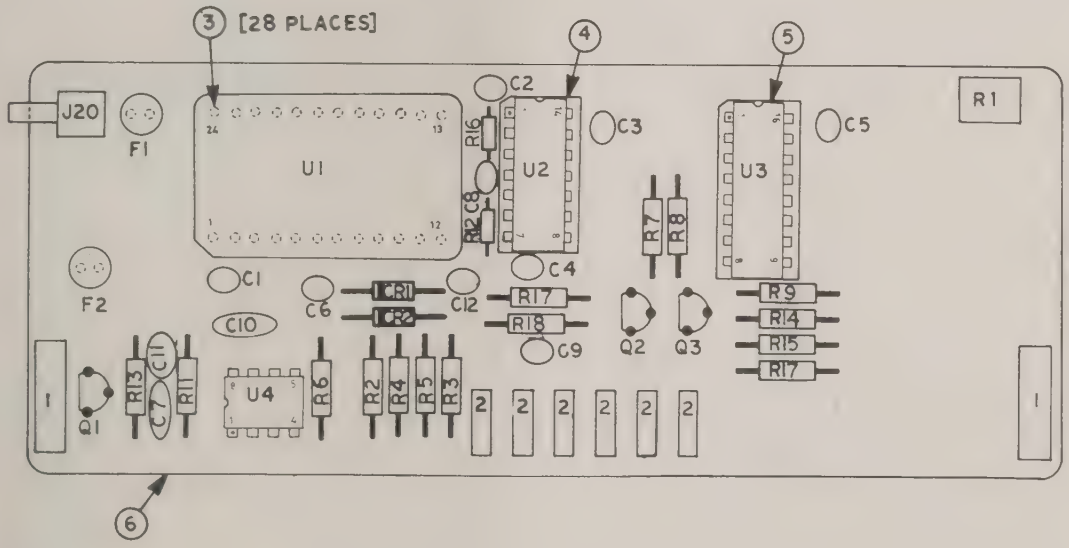


Figure 5-10 Data Output Unit PCB Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	1000 MHz PRESCALER PCB ASSEMBLY	393639	89536	396309	1		
	1250 MHz PRESCALER PCB ASSEMBLY Figure 5-12	405589	89536	405589	1		
C1,C6, C8,C9	Cap., 0.001 uF	402966	71590		8		
C7, C10	Cap., 0.001 uF, 500 V	357806	71590	CF102	2		
C11	Cap., Tant. 10 uF, 16 V, 20%	193623	56289		1		
C12	Cap., Chip, 3.9 pF (1.256 Hz version only)	0274			1		
F1,F2	FUSE, 0.2 A, 2.6 ohms	370577	75915	273.200	2		
J20	Coax. Connector, SNAP-ON, PCB MOUNT RIGHT ANGLE, CON-HEX TYPE	353243	98291	51.053.000	1		
Q1,Q3	TRANSISTOR, TIS 98, NPN, Si,LoP	369678	01295	TIS98	2		
Q2	TRANSISTOR, TCS 103, PNP, Sm Sig, Si	381780	01295	TCS103	1		
CR1, CR2	DIODE, HOT CARRIER, FH 1100	369595	07263	FH1100	2		
R1	TRIMPOT, 10 K, VAR. R., 20%	385393	Piher	PT 10H 10K	1		
R3,R5, R13, R17	Res., 1/4W, 5%, 2.7 K, CC	170720	01121	CB	4		
R4, R11	Res., 1/4W, 5%, 10 K, CC	148106	01121	CB	2		
R2,R6	Res., 1/4W, 5%, 330 K, CC	192948	01121	CB	2		
R9	Res., 1/4W, 5%, 4.7 K, CC	148072	01121	CB	1		
R10, R16	Res., 1/4W, 5%, 1 K, CC	148023	01121	CB	2		
R7,R8 R15	Res., 1/4W, 5%, 470, CC	147983	01121	CB	3		
R12, R18	Res., 1/8W, 10%, 51, CC	266262			2		
R14	Res., 1/4W, 5%, 1.5 K, CC	148031	01121	CB	1		
U1-A	AMPLIFIER, CA 1040 (1 GHz version only)	404566	Opti -	CA 1040	1		
U1-A	AMPLIFIER, CA 1040A(1.25 GHz version only)	418178	Opti -	CA 1040A	1		
U2-A	I.C. 11C05 (1 GHz version only)	402719	07263	11C05	1		
U2-A	I.C. 11C05A (1.25 GHz version only)	402719A	07263	11C05 A	1		
U3	I.C. 11C06	404574	07263	11C06	1		
U4	I.C. uA 741, MINI-DIP, 8 PIN, OP AMP	402750	07263	uA 741	1		

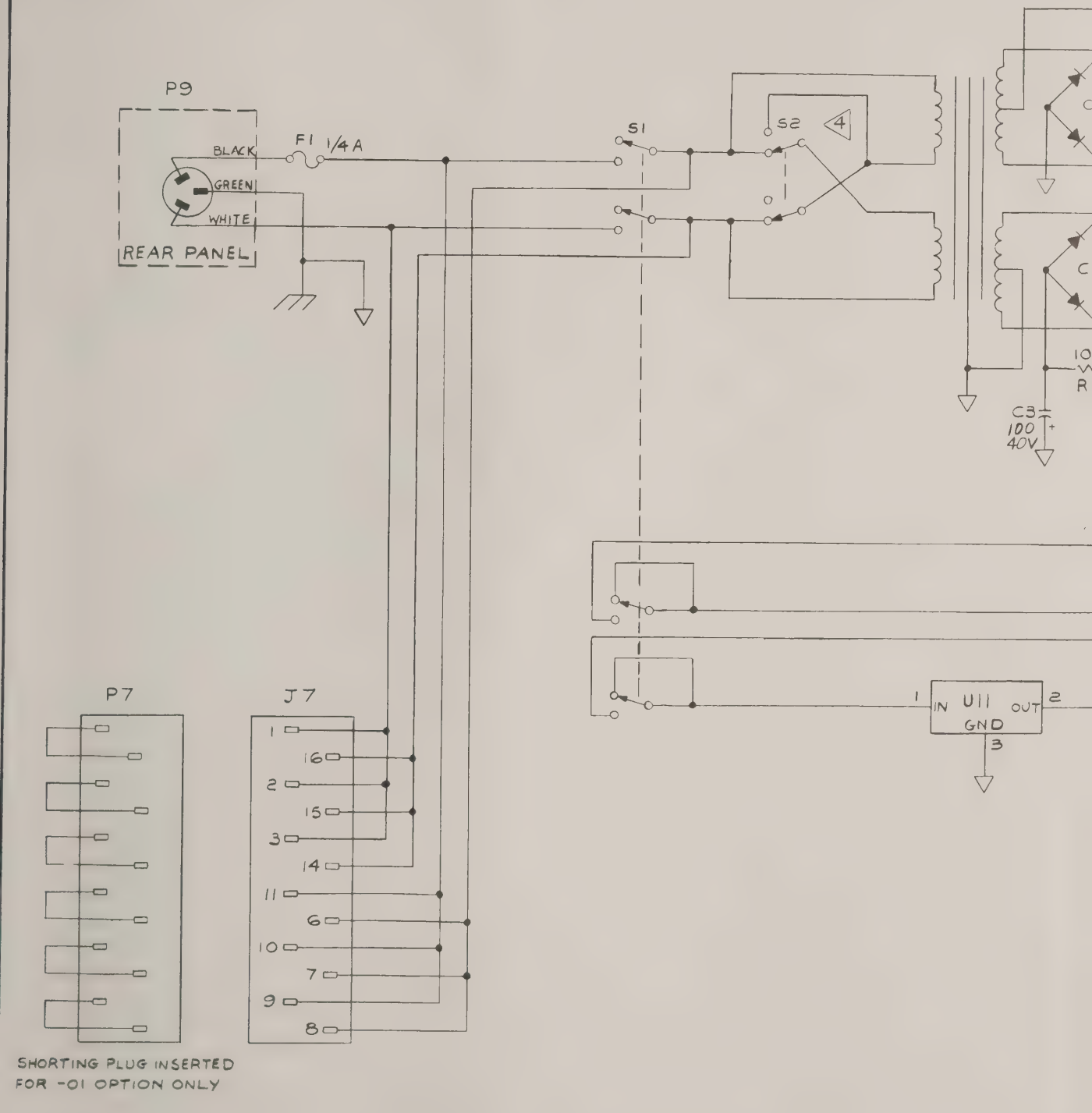
Rev

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
1	Connector, Test Jack No. 105-0753	149112	74970	105-0753	2		
2.	AMP Receptacle	375329	00779	85863-3	6		
3	Socket, Miniature	403642	00779	50863-B	28		
4	I.C. Socket, L.P., 14 PIN	291542	00779	583527-1	1		
5	I.C. Socket, L.P., 16 PIN	370312	01295	C931602	1		
6	1 GHz & 1.25 GHz PRESCALER PCB	396085	89536	396085	1		



Section 6

Schematic Diagrams


P9
BLACK
GREEN
WHITE
REAR PANEL
F1 1/4A
S1
S2
4
C3
100
40V
U11
IN
GND
OUT
1
2
3
P7
J7
1
16
2
15
3
14
11
6
10
7
9
8
SHORTING PLUG INSERTED
FOR -01 OPTION ONLY

REV

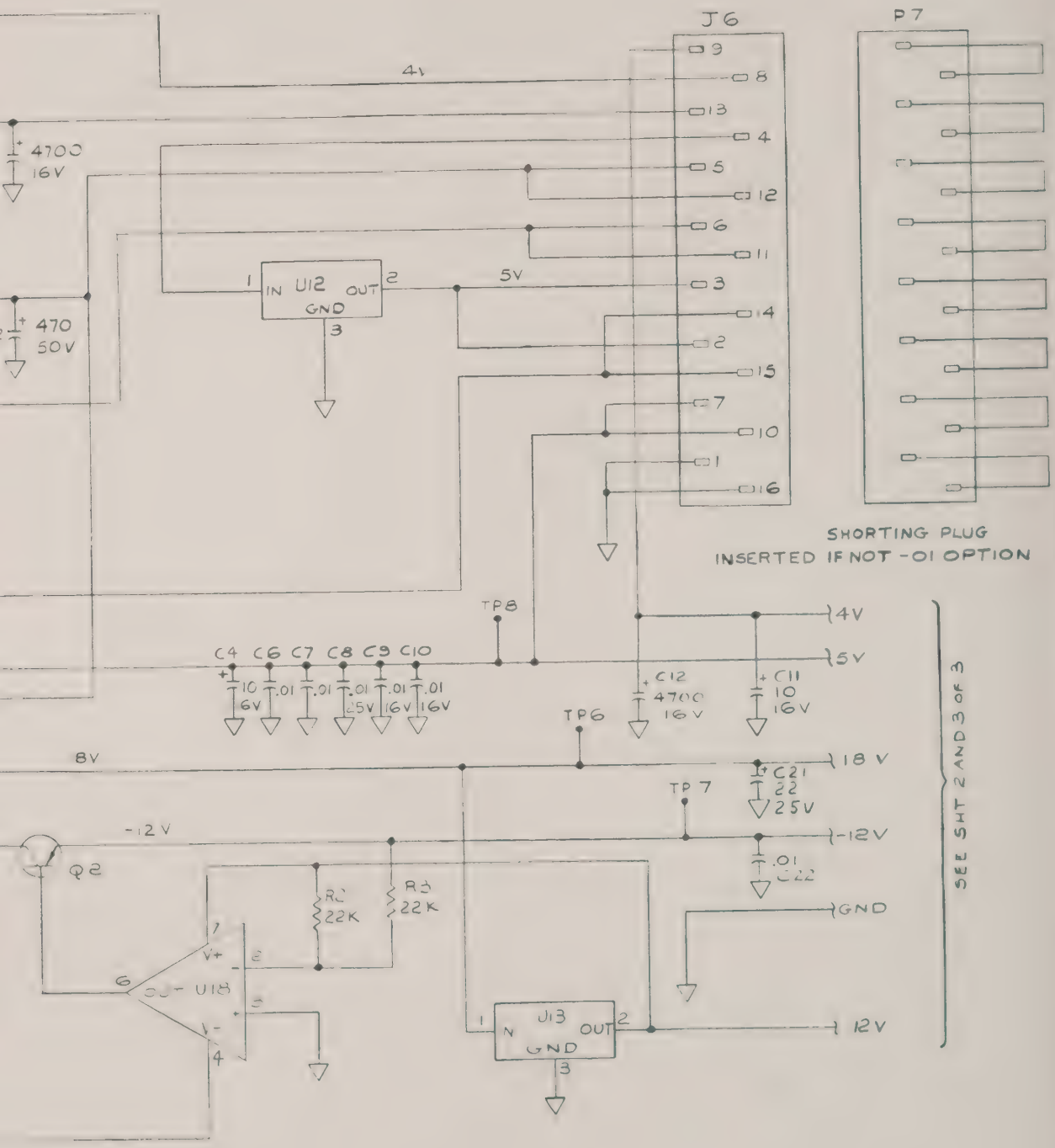
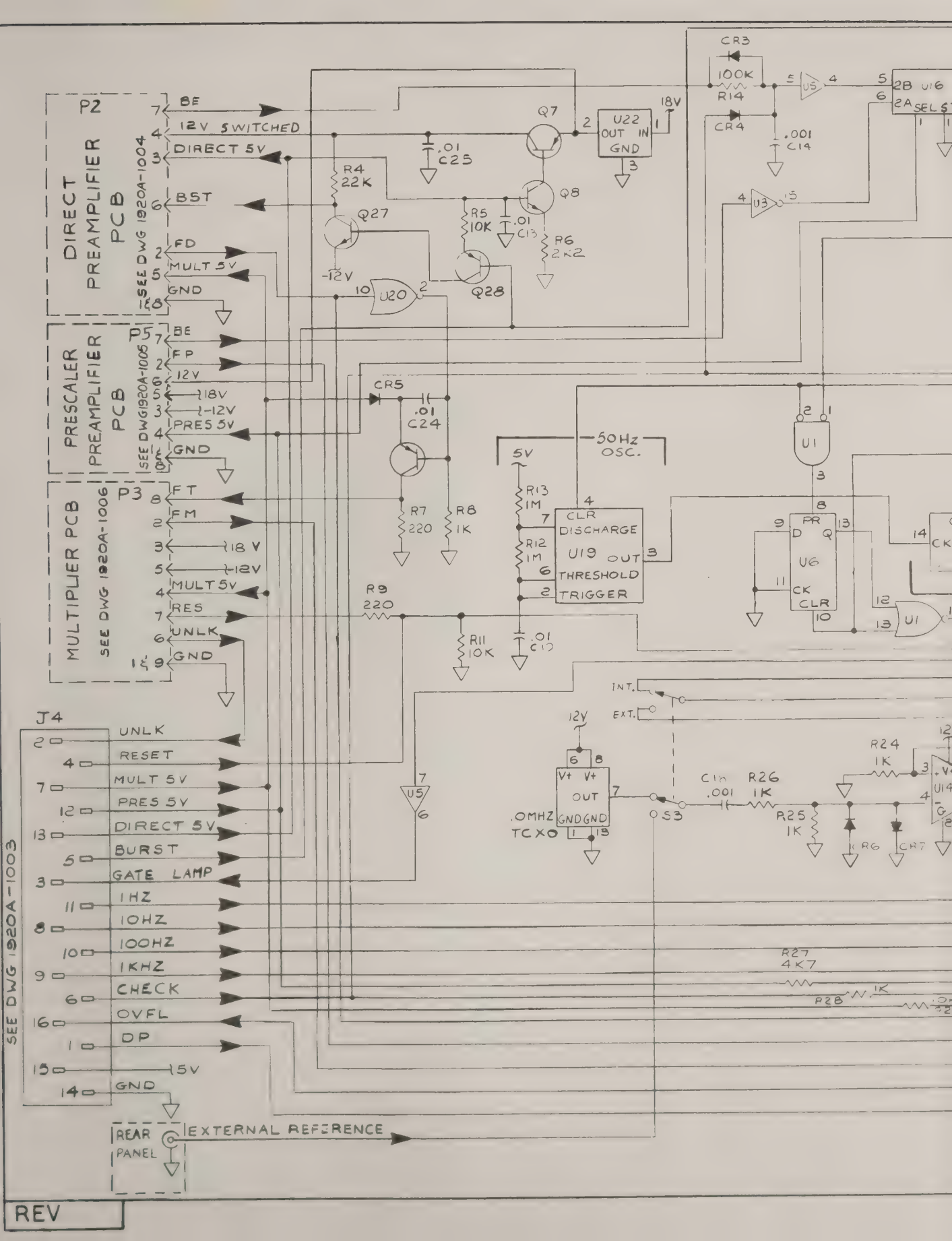


Figure 6-1 Main PCB Schematic (Sheet 1 of 3)


P2
DIRECT PREAMPLIFIER PCB
SEE DWG 1820A-1004
BE
12V SWITCHED
DIRECT 5V
BST
FD
MULT 5V
GND
P5
PRESCALER PREAMPLIFIER PCB
SEE DWG1820A-1005
BE
FP
12V
18V
-12V
PRES 5V
GND
P3
MULTIPLIER PCB
SEE DWG 1820A-1006
FT
FM
18 V
-12V
MULT 5V
RES
UNLK
GND
J4
UNLK
RESET
MULT 5V
PRES 5V
DIRECT 5V
BURST
GATE LAMP
1HZ
10HZ
100HZ
1KHZ
CHECK
OVFL
DP
15V
GND
SEE DWG 1820A-1003
REAR PANEL
EXTERNAL REFERENCE
Q7
Q8
Q27
Q28
U22
OUT IN GND
18V
R4 22K
R5 10K
R6 2K2
.01 C25
.01 C13
-12V
U20
CR3
100K R14
CR4
.001 C14
U5
U3
U16
2B
2A
SEL
CR5
.01 C24
R7 220
R8 1K
5V
50Hz OSC.
R13 1M
R12 1M
U19
CLR
DISCHARGE
OUT
THRESHOLD
TRIGGER
R9 220
R11 10K
.01 C12
U1
U6
PR
D
Q
CK
CLR
INT.
EXT.
12V
.0MHZ TCXO
V+ V+
OUT
GND GND
S3
C16 .001
R26 1K
R25 1K
R24 1K
CR6
CR7
U14
R27 4K7
R28 1K
REV

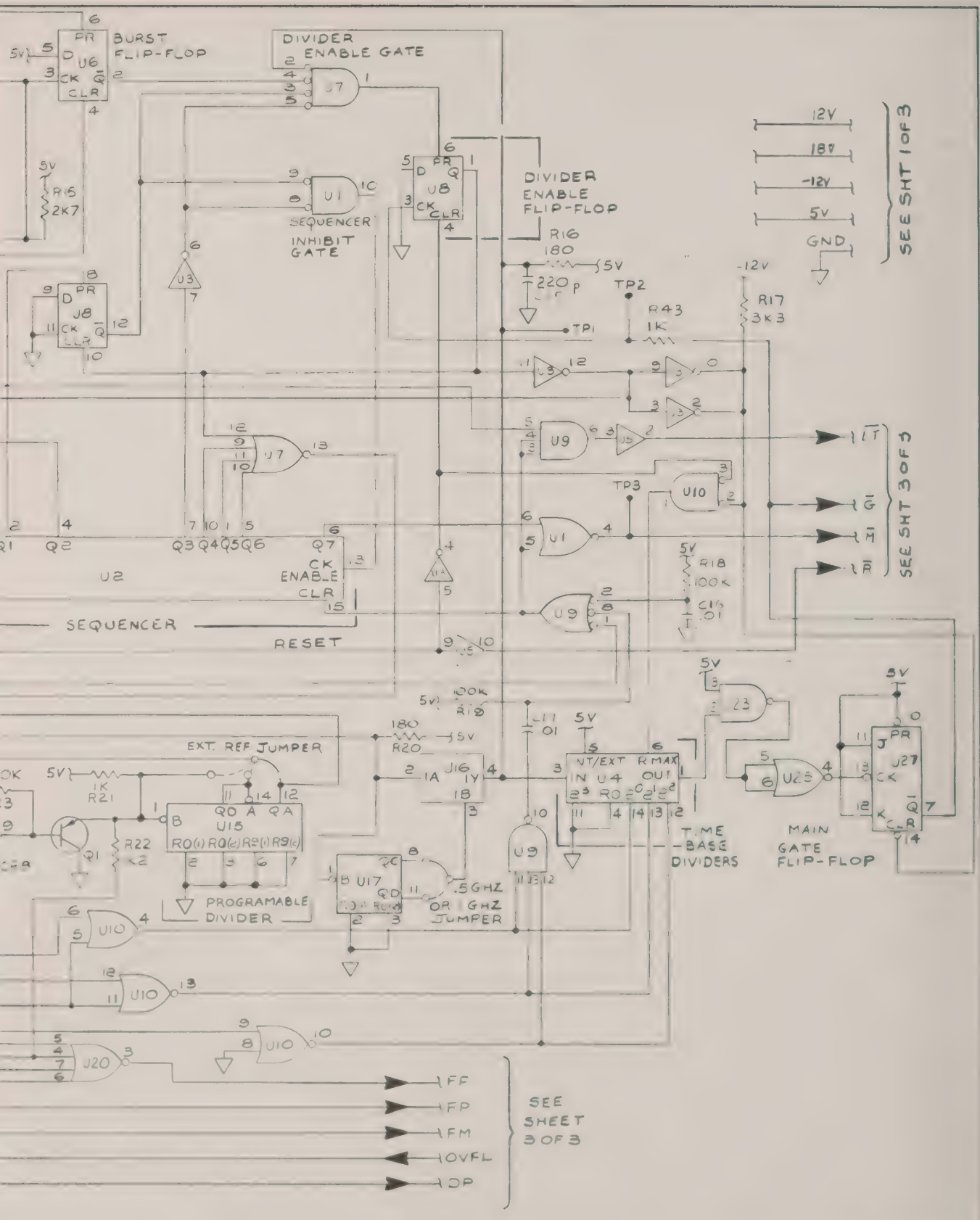
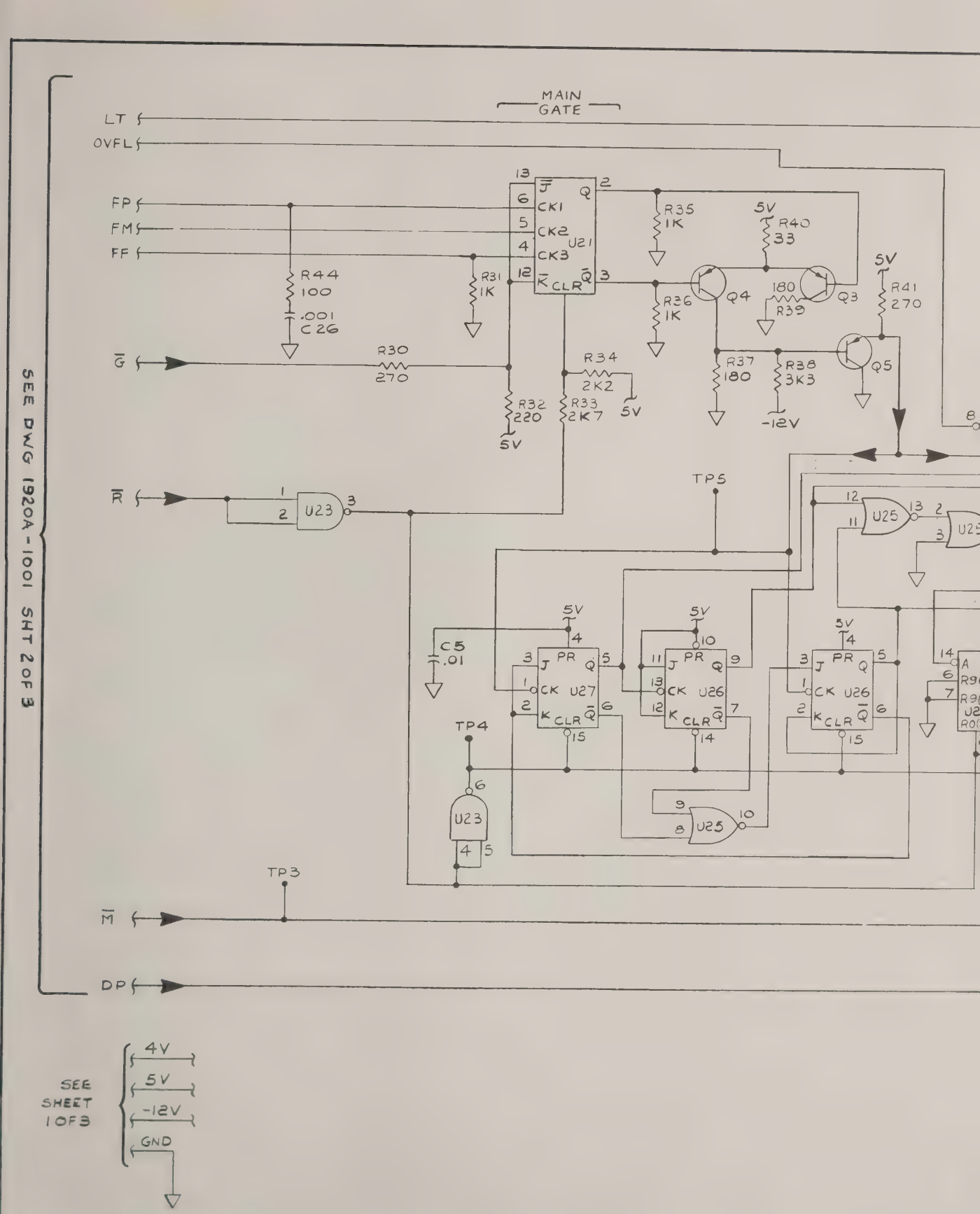


Figure 6-1 Main PCB Schematic (Sheet 2 of 3)


MAIN GATE
LT
OVFL
FP
FM
FF
U21
R44 100 .001 C26
R31 1K
R35 1K
R36 1K
R40 33
R39 180
R41 270
Q4
Q3
Q5
R30 270
R34 2K2
R32 220
R33 2K7
R37 180
R38 3K3
5V
-12V
R
G
M
DP
U23
U25
U27
U26
TP3
TP4
TP5
C5 .01
SEE DWG 1920A-1001 SHT 2 OF 3
SEE SHEET 1 OF 3
4V
5V
-12V
GND
REV

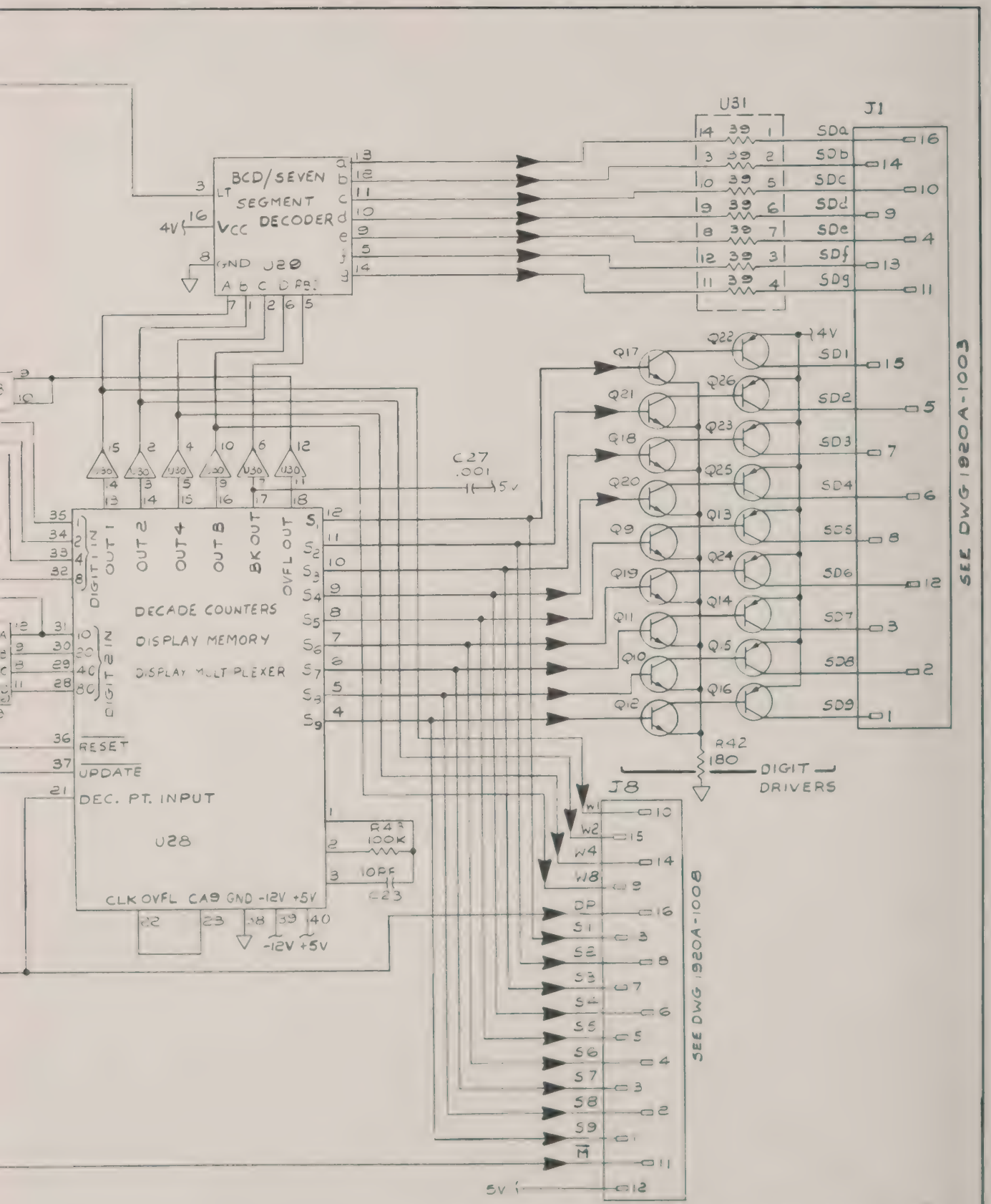
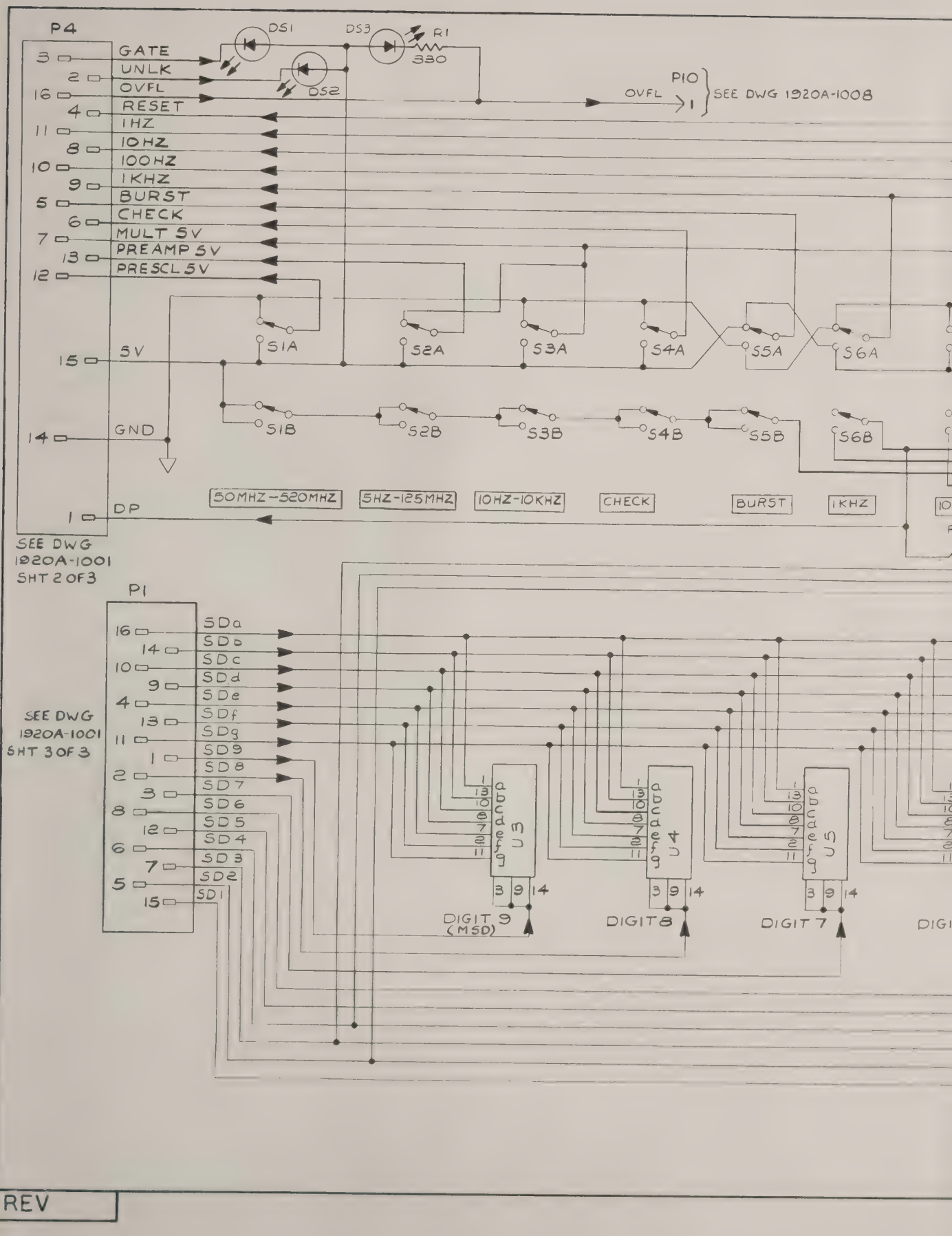


Figure 6-1 Main PCB Schematic (Sheet 3 of 3)


P4
GATE
UNLK
OVFL
RESET
1HZ
10HZ
100HZ
1KHZ
BURST
CHECK
MULT 5V
PREAMP 5V
PRESCL 5V
5V
GND
DP
DS1
DS2
DS3
R1
330
P10
SEE DWG 1920A-1008
S1A
S2A
S3A
S4A
S5A
S6A
S1B
S2B
S3B
S4B
S5B
S6B
50MHZ-520MHZ
5HZ-125MHZ
10HZ-10KHZ
CHECK
BURST
1KHZ
SEE DWG 1920A-1001 SHT 2 OF 3
P1
SEE DWG 1920A-1001 SHT 3 OF 3
SDa
SDb
SDc
SDd
SDe
SDf
SDg
SD9
SD8
SD7
SD6
SD5
SD4
SD3
SD2
SD1
DIGIT 9 (MSD)
DIGIT 8
DIGIT 7

REV

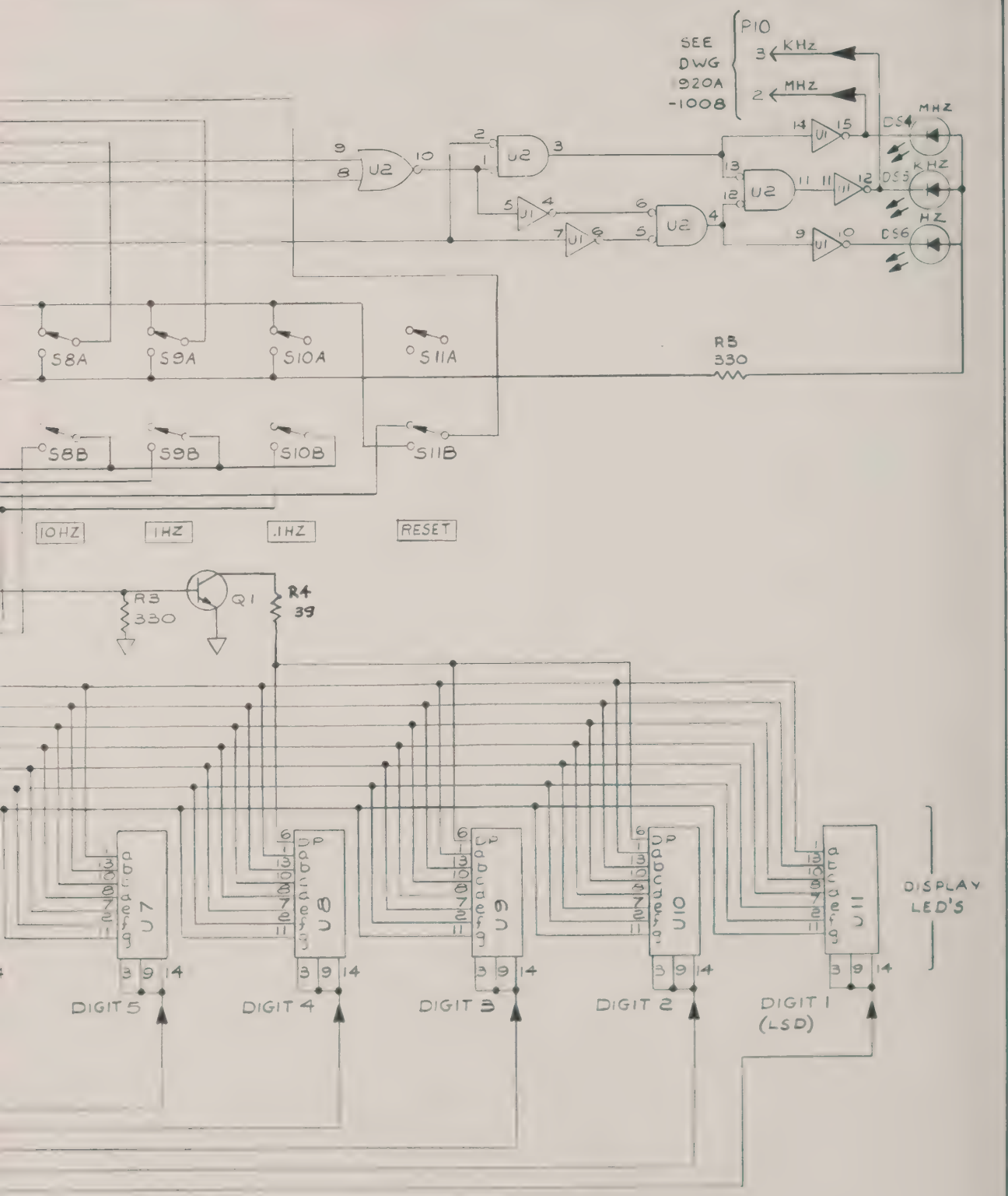
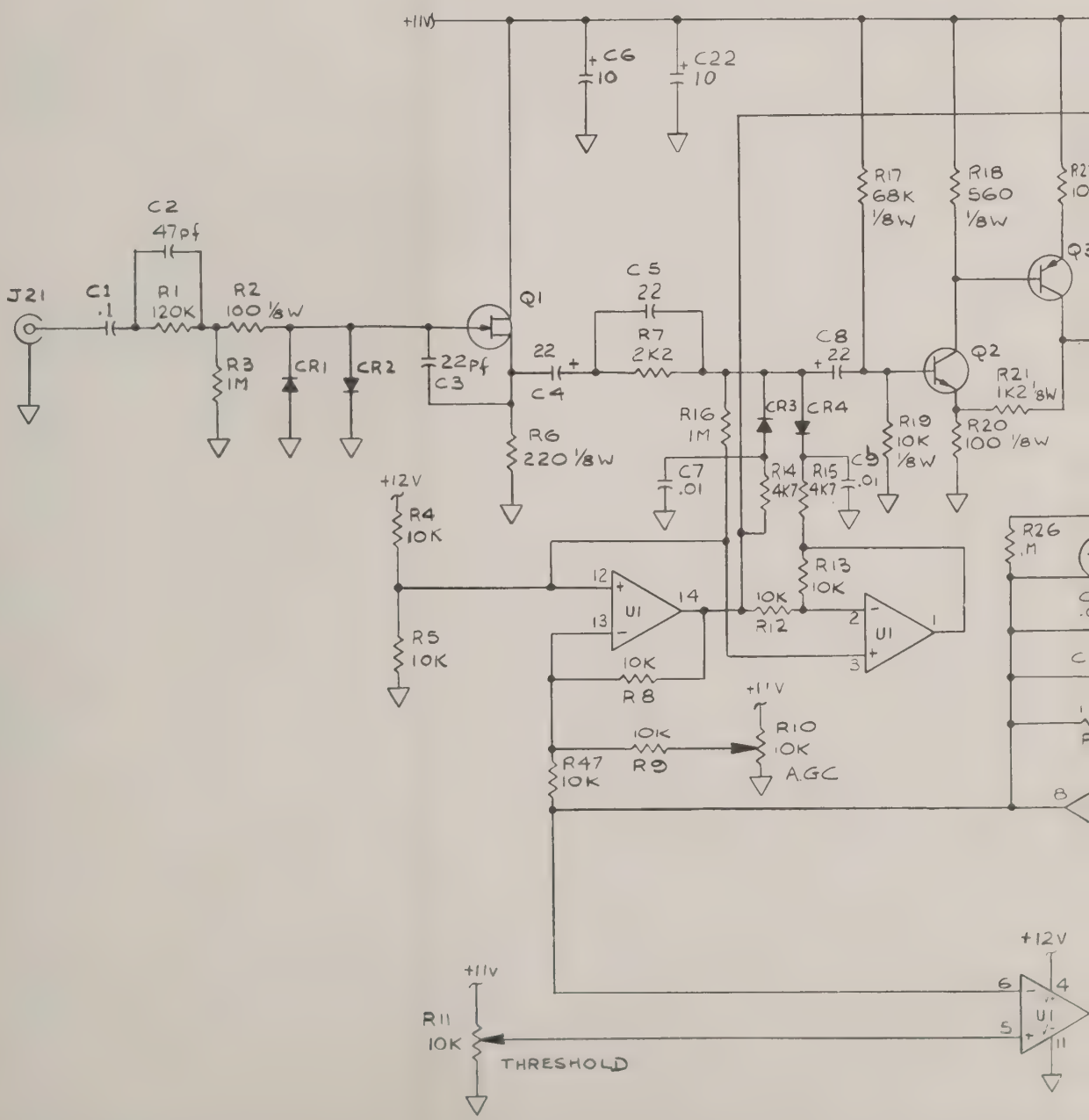


Figure 6-2 Display PCB Schematic


+11V
C6
10
C22
10
C2
47pf
J21
C1
.1
R1
120K
R2
100 1/8W
R3
1M
CR1
CR2
22pf
C3
Q1
C5
22
R7
2K2
22
C4
C8
22
R17
68K
1/8W
R18
560
1/8W
Q2
R21
1K2 1/8W
R20
100 1/8W
R19
10K
1/8W
R16
1M
CR3
CR4
R14
4K7
R15
4K7
C9
.01
C7
.01
R6
220 1/8W
+12V
R4
10K
R5
10K
U1
R13
10K
10K
R12
R8
10K
R26
.1M
+11V
R10
10K
A.GC
R47
10K
R9
10K
+11v
R11
10K
THRESHOLD
+12V
U1

REV

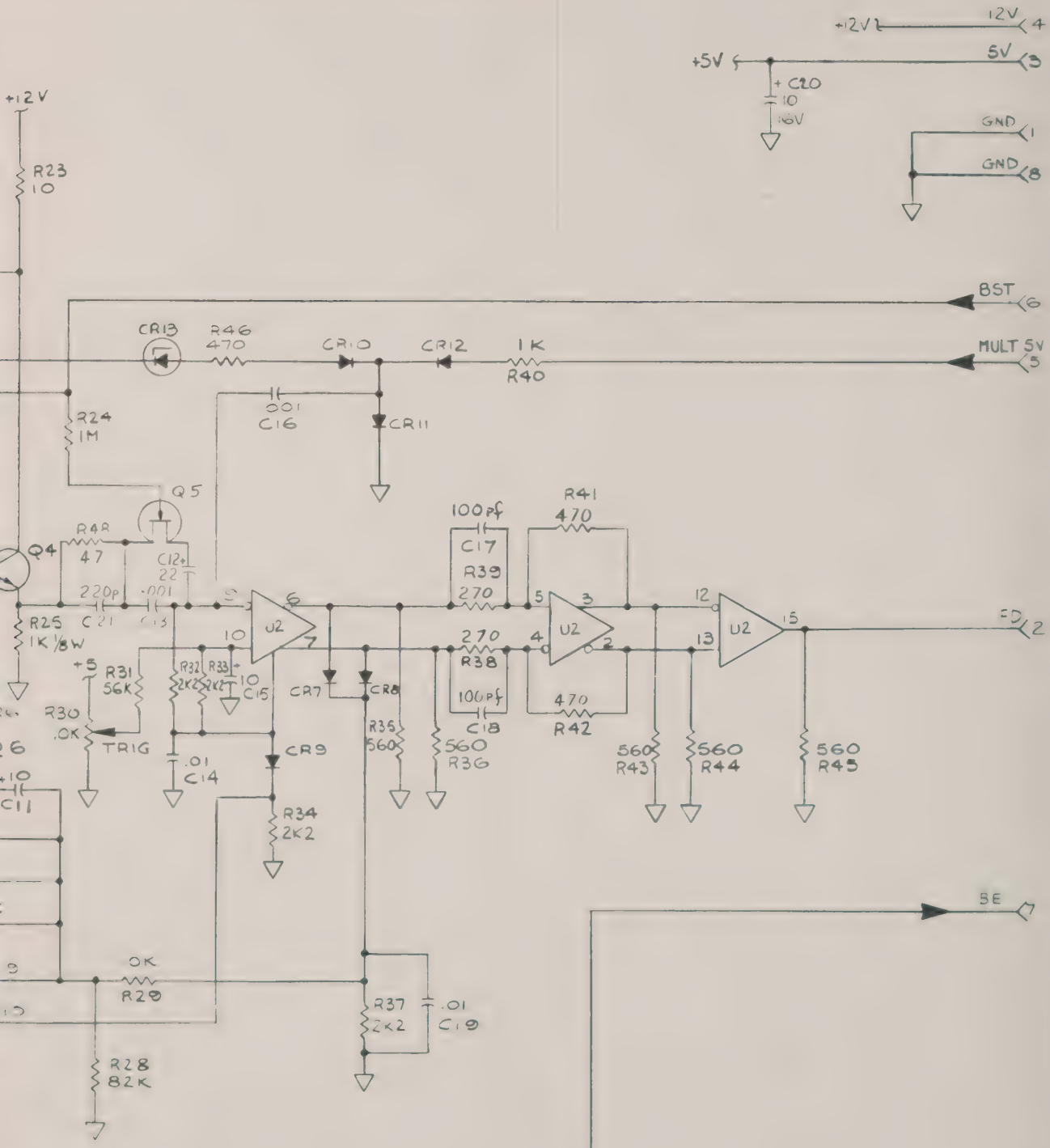
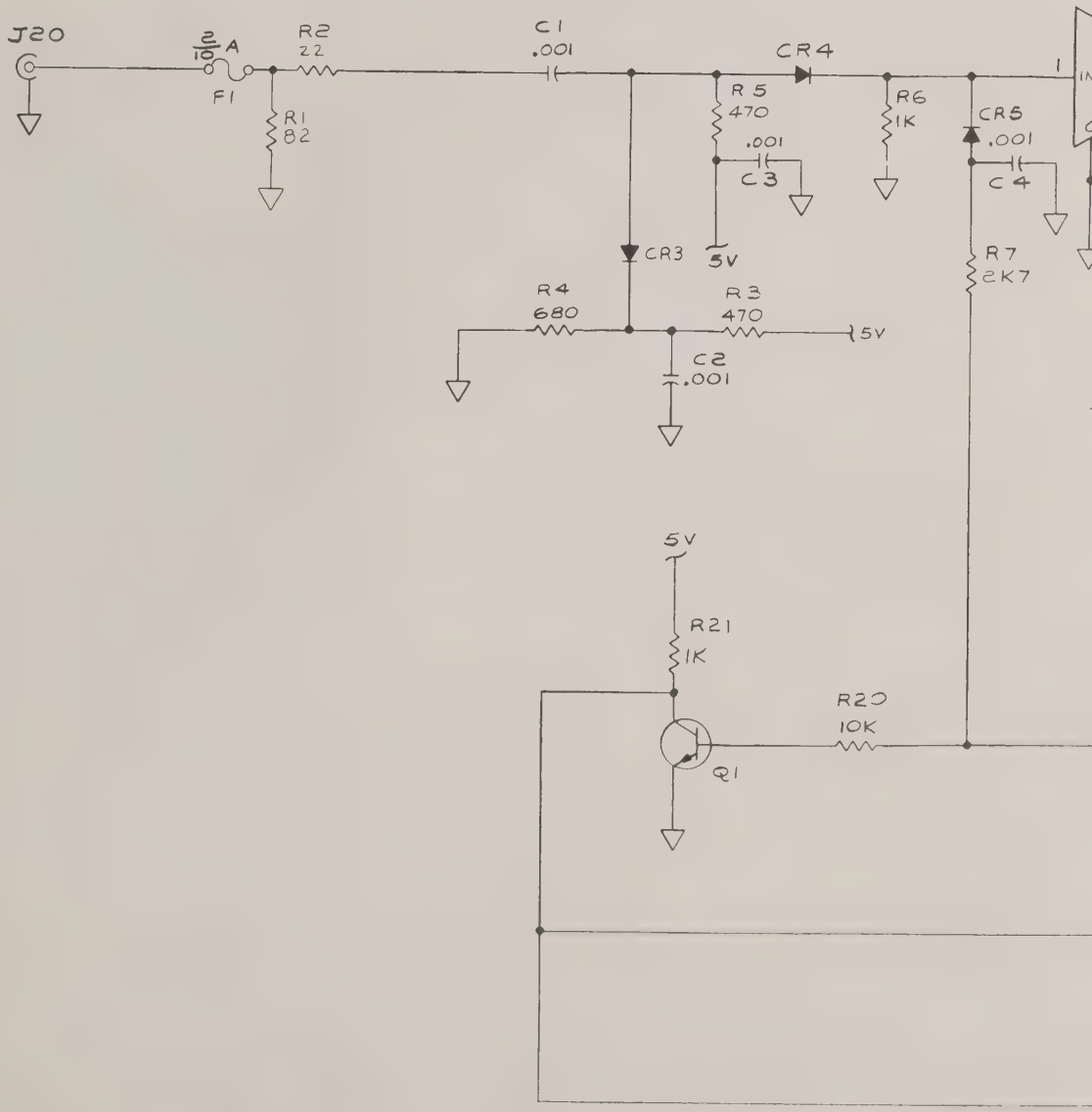


Figure 6-3 Direct Preamplifier PCB Schematic


J20
2/10 A
F1
R2
22
R1
82
C1
.001
CR4
R5
470
.001
C3
R6
1K
CR5
.001
C4
CR3
5V
R4
680
R3
470
5V
C2
.001
R7
2K7
5V
R21
1K
R20
10K
Q1

REV A

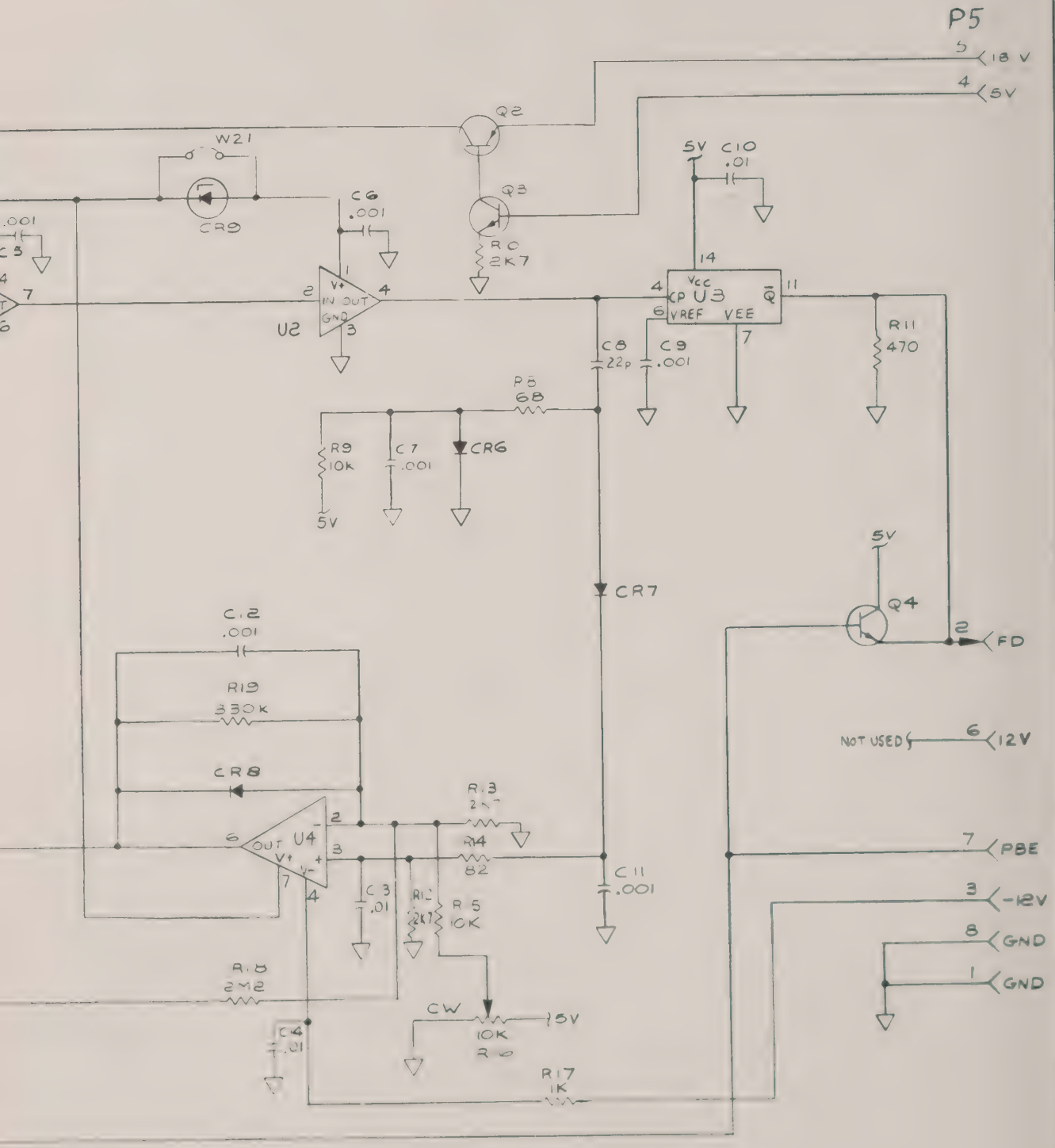
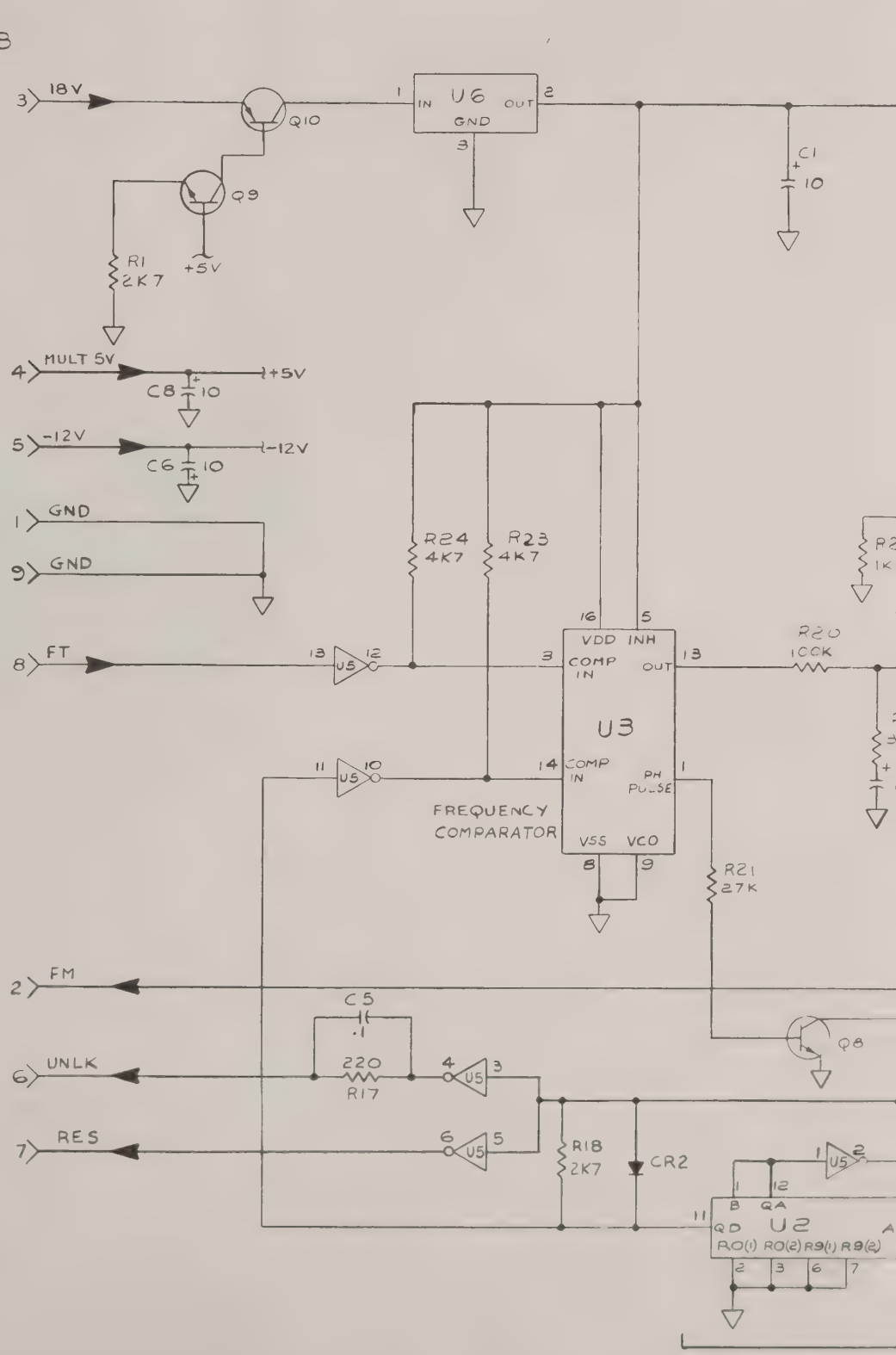


Figure 6-4 Prescaler PCB Schematic, 520 MHz


P3
3 18V
Q10
Q9
1 IN U6 GND OUT 2
3
C1 10
R1 2K7
+5V
4 MULT 5V
+5V
C8 10
5 -12V
-12V
C6 10
1 GND
9 GND
R24 4K7
R23 4K7
16 VDD INH 5
8 FT
13 U5 12
3 COMP IN
U3
OUT 13
R20 100K
11 U5 10
14 COMP IN
PH PULSE 1
FREQUENCY COMPARATOR
VSS VCO
8 9
R21 27K
2 FM
C5 .1
Q8
6 UNLK
220 R17
4 U5 3
7 RES
6 U5 5
R18 2K7
CR2
1 U5 2
12
B QA
11 QD U2
RO(1) RO(2) R9(1) R9(2)
2 3 6 7
SEE DWG 1920A-1001 SHT 2 OF 3
REV

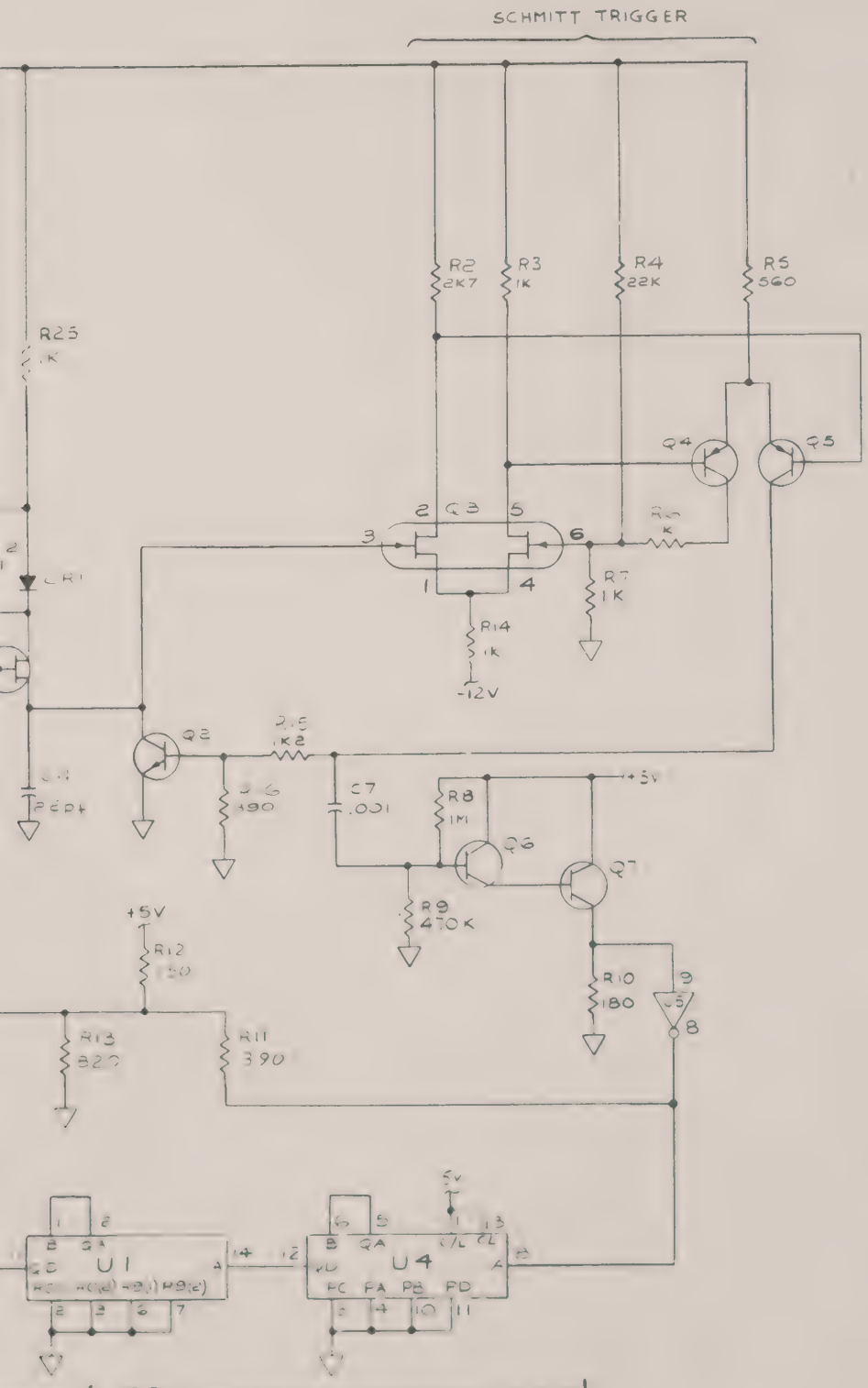
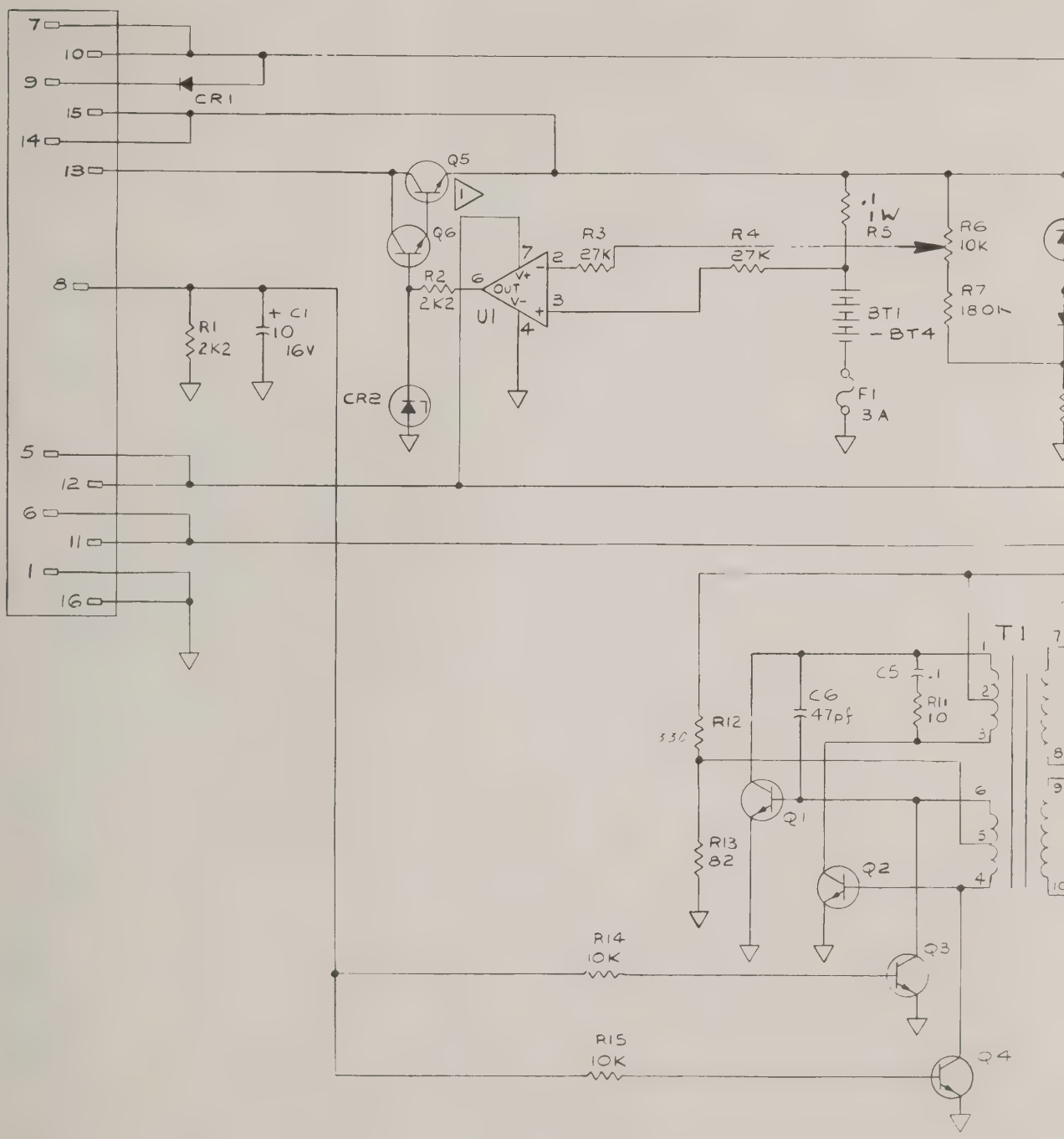


Figure 6-5 Multiplier PCB Schematic


7
10
9
15
14
13
8
5
12
6
11
1
16
CR1
Q5
Q6
R2
2K2
R1
2K2
+ C1
10
16V
U1
V+
OUT
V-
R3
27K
R4
27K
.1
1W
R5
R6
10K
R7
180K
BT1
-BT4
F1
3A
CR2
T1
C5
.1
C6
47pf
R11
10
R12
330
R13
82
Q1
Q2
Q3
Q4
R14
10K
R15
10K

REV

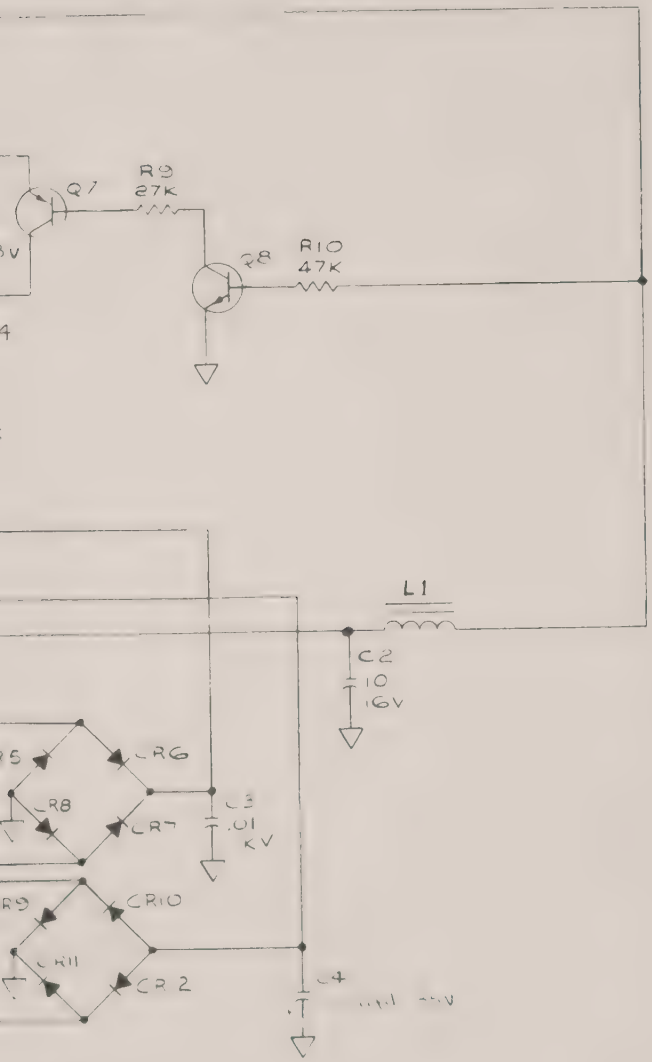
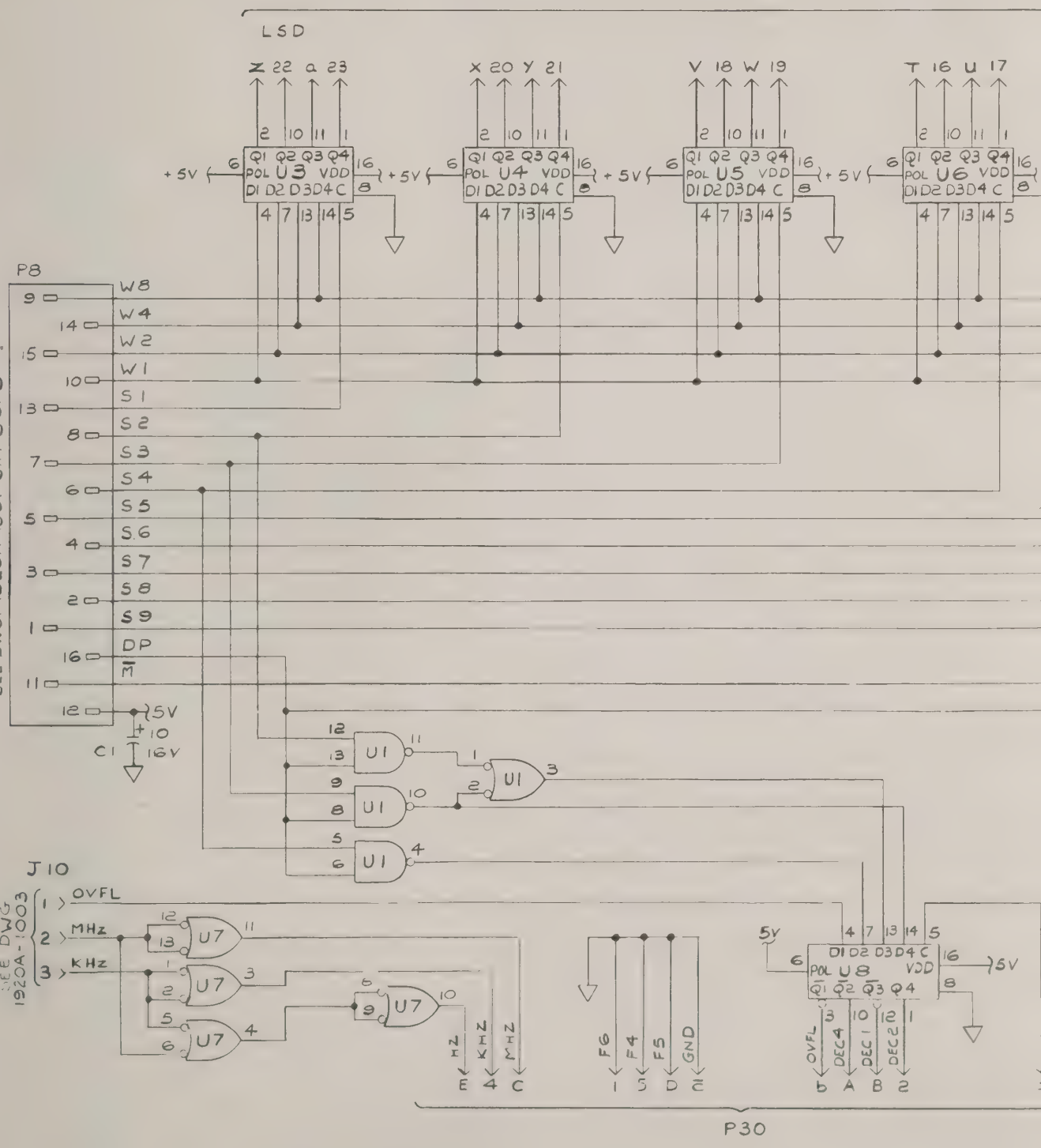


Figure 6-6 Battery PCB Schematic


LSD
Z 22 a 23
X 20 Y 21
V 18 W 19
T 16 U 17
U3
U4
U5
U6
U8
+5V
P8
W8
W4
W2
W1
S1
S2
S3
S4
S5
S6
S7
S8
S9
DP
M
SEE DWG 1920A-1001 SHT 3 OF 3
C1
10
16V
J10
OVFL
MHz
KHz
SEE DWG 1920A-1003
U1
U7
F6
F4
F5
GND
OVFL
DEC4
DEC1
DEC2
P30
REV

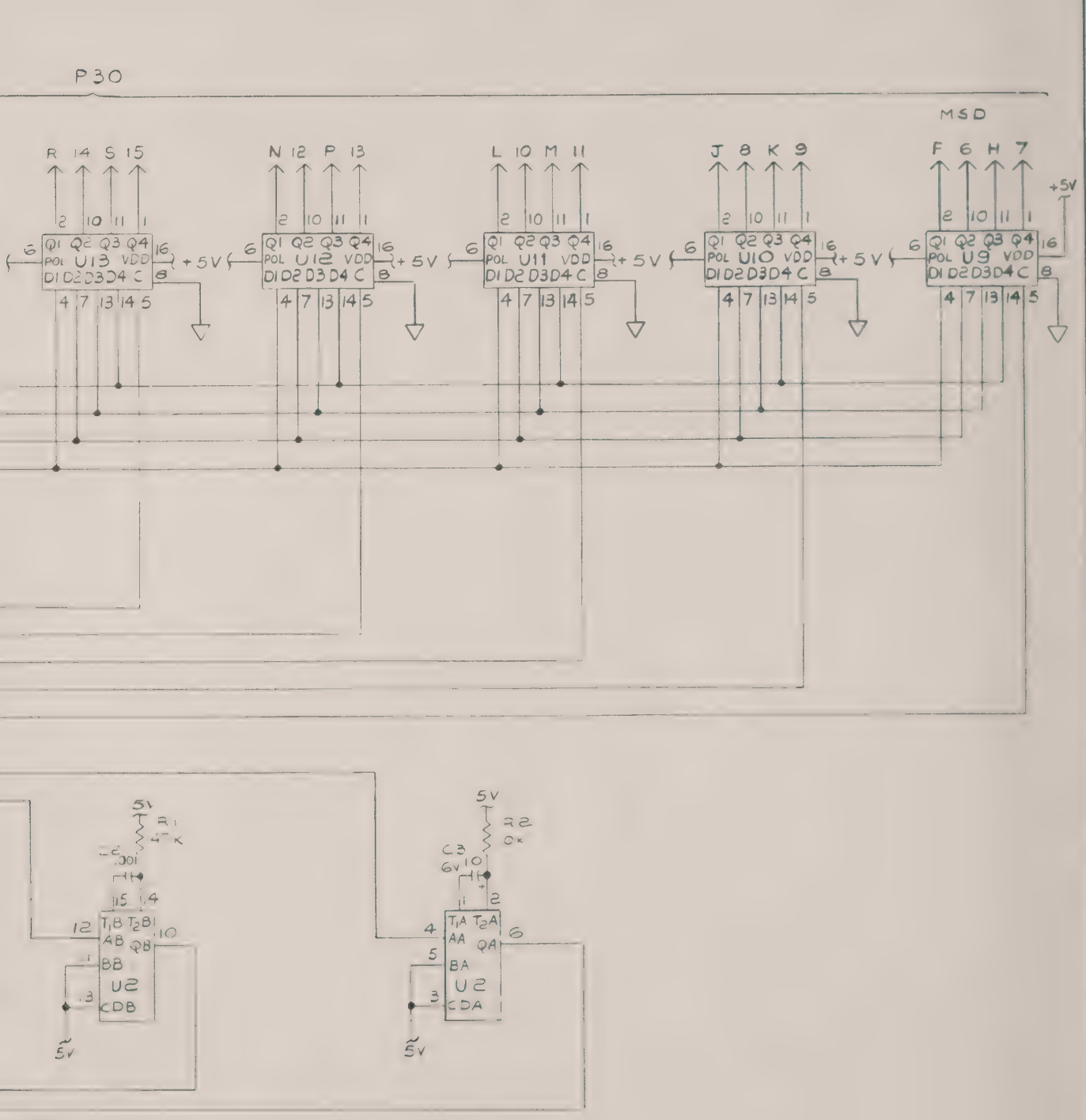
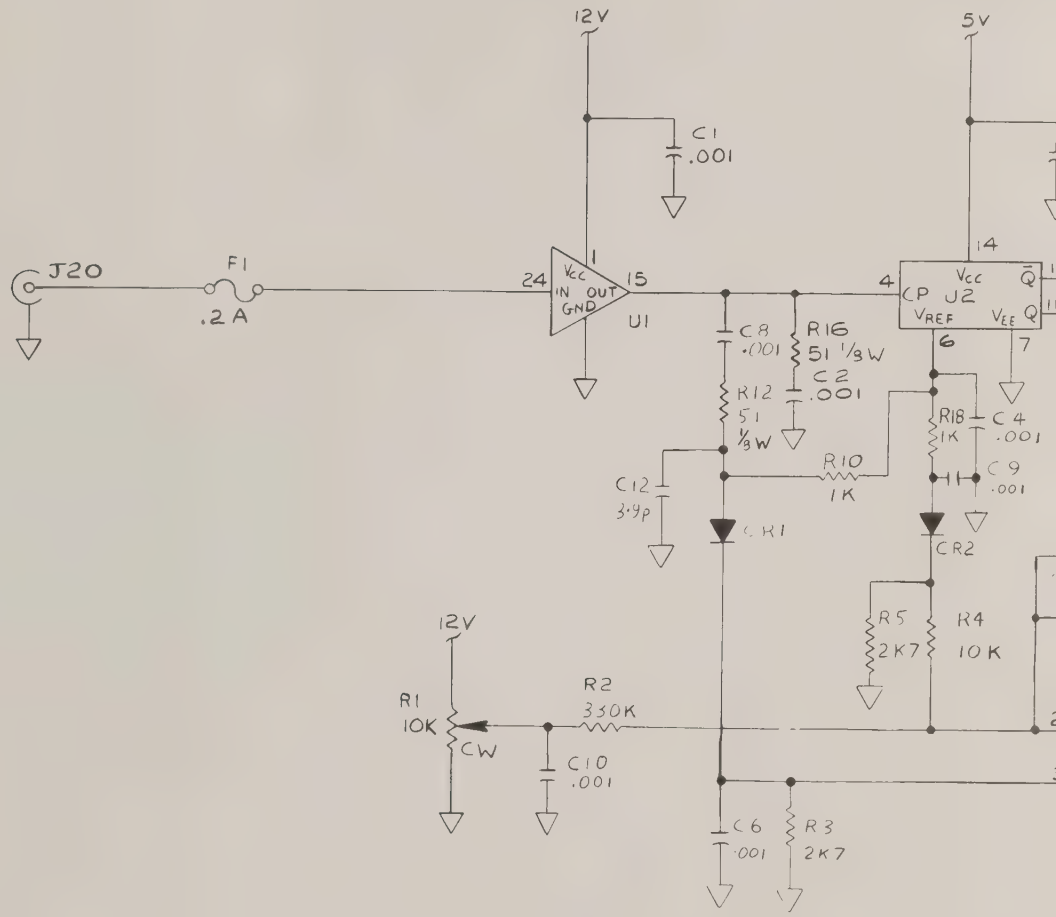


Figure 6-7 Data Output Unit PCB Schematic


12V
5V
C1
.001
J20
F1
.2 A
24
Vcc
IN
OUT
GND
15
1
U1
14
4
Vcc
CP U2
VREF
VEE
Q
6
7
C8
.001
R16
51 1/3W
C2
.001
R12
51
1/3W
R18
1K
C4
.001
C9
.001
R10
1K
C12
3·9p
CR1
CR2
R5
2K7
R4
10K
12V
R1
10K
CW
R2
330K
C10
.001
C6
.001
R3
2K7

REV

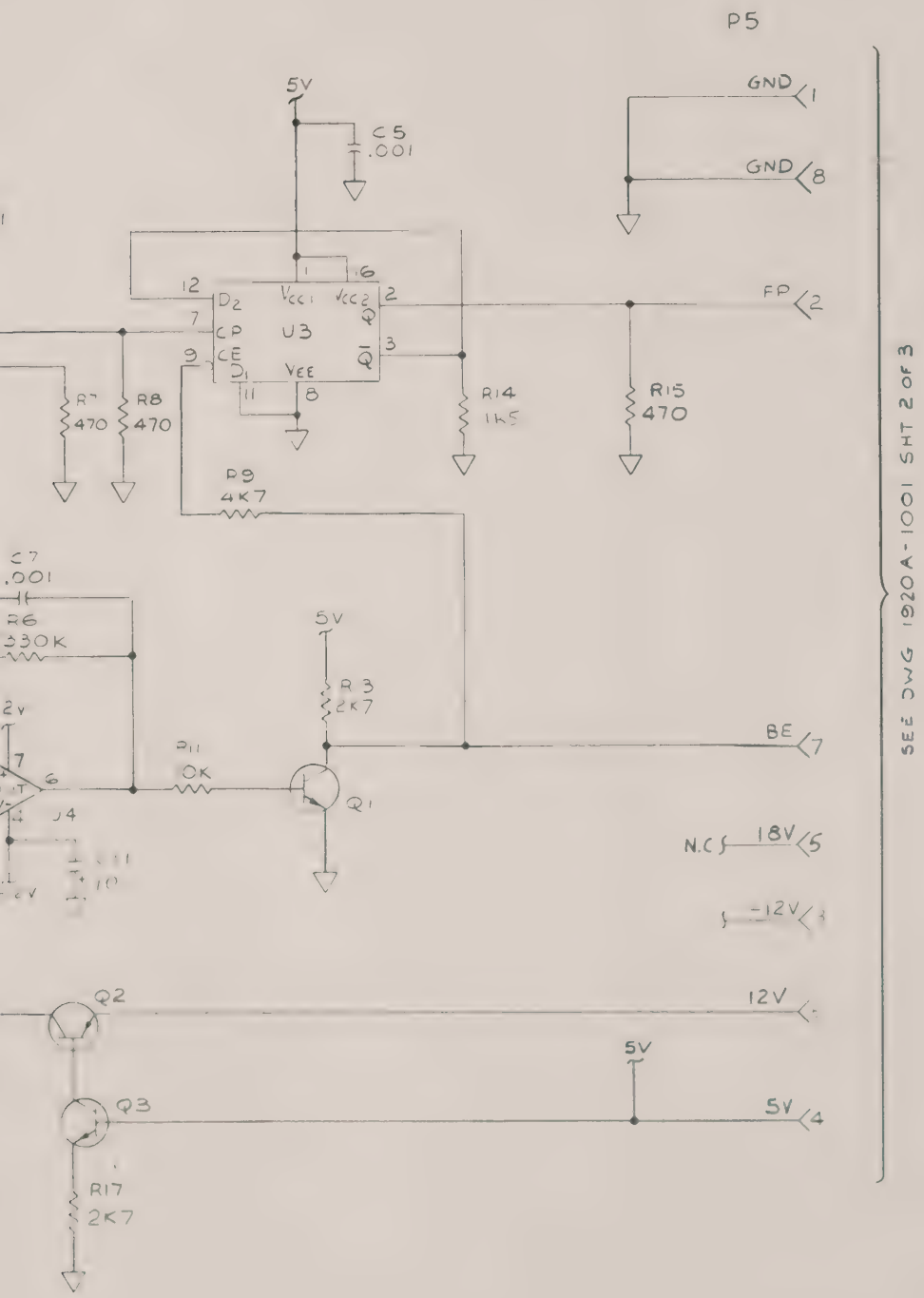


Figure 6-8 Prescaler PCB Schematic, 1000 MHz

Appendix A

Federal Supply Code for Manufacturers

A-1. CODE TO NAME

A-2. The following five digit code numbers are listed in numerical sequence along with the manufacturer's name and address to which the code has been assigned. The Federal Supply Code has been taken from Cataloging Handbook H 4-2, Code to Name.

00213	Sage Electronics Corp. Rochester, New York
00327	Welwyn International, Inc. Westlake, Ohio
00656	Aerovox Corp. New Bedford, Massachusetts
00686	Film Capacitors Passaic, New Jersey
00779	AMP Inc. Harrisberg, Pennsylvania
01121	Allen-Bradley Co. Milwaukee, Wisconsin
01281	TRW Semiconductors Lawndale, California
01295	Texas Instruments, Inc. Semiconductor Components Div. Dallas, Texas
01686	RCL Electronics Inc. Manchester, New Hampshire
01730	Deleted
01884	Dearborn Electronics Inc. Orlando, Florida
02114	Ferroxcube Corp. Saugerties, New York
02606	Replaced by 15801
02660	Amphenol-Borg Elect. Corp. Broadview, Illinois
02799	Arco Capacitors, Inc. Torrence, California
03508	General Electric Co. Semiconductor Products Syracuse, New York
03614	Replaced by 71400
03651	Replaced by 44655
03797	Eldema Corp. Compton, California
03877	Transitron Electronic Corp. Wakefield, Massachusetts
03888	Pyrofilm Resistor Co., Inc. Cedar Knolls, New Jersey
03911	Clairex Corp. New York, New York
03980	Muirhead Instruments, Inc. Mountainside, New Jersey
04009	Arrow Hart and Hegemen Electronic Company Hartford, Connecticut
04062	Replaced by 72136
04202	Replaced by 81312
04217	Essex Wire Corp. Wire & Cable Div. Anaheim, California
04221	Aemco, Div. of Midtex Inc. Mankato, Minnesota
04222	Aerovox Corp. (H-Q) Myrtle Beach, South Carolina
04645	Replaced by 75376
04713	Motorola Semiconductor Products Inc. Phoenix, Arizona
05082	Replaced by 94154
05236	Jonathan Mfg. Co. Fullerton, California
05277	Westinghouse Electric Corp. Semiconductor Dept. Youngwood, Pennsylvania
05278	Replaced by 43543
05397	Union Carbide Corp. Electronics Div. Cleveland, Ohio
05279	Southwest Machine & Plastic Co. Los Angeles, California
05397	Union Carbide Corp. Electronics Div. New York, New York
05571	Sprague Electric Co. Pacific Div. Los Angeles, California
05574	Viking Industries Chaisworth, California
05704	Alac, Inc. Glendale, California
05820	Wakefield Engineering Ind. Wakefield, Massachusetts
06001	General Electric Company Capacitor Department Irmo, South Carolina
06136	Replaced by 63743
06473	Amphenol Space & Missile Sys. Chatsworth, California
06555	Beede Electrical Instrument Co. Penacook, New Hampshire
06739	Electron Corp. Littletown, Colorado
06743	Clevite Corp. Cleveland, Ohio
06751	Semcor Div., Components, Inc. Phoenix, Arizona
06860	Gould National Batteries Inc. City of Industry, California
06980	Varian-Eumac San Carlos, California
07115	Replaced by 14674
07138	Westinghouse Electric Corp., Electronic Tube Division Elmira, New York
07256	Silicon Transistor Corp. Garden City, New York
07263	Fairchild Semiconductor Div. of Fairchild Camera & Instrument Corp. Mountain View, California
07344	Bircher Co., Inc. Rochester, New York
07792	Lerma Engineering Corp. Northampton, Massachusetts
07910	Teledyne Corp. (Continental Device) Hawthorne, California
08225	Industro Transistor Corp. Long Island City, New York
08530	Reliance Mica Corp. Brooklyn, New York
08792	Discontinued
08806	General Electric Co. Miniature Lamp Dept. Cleveland, Ohio
08863	Nylomatic Corp. Norrisville, Pennsylvania
08988	Skottie Electronics Inc. Archbald, Pennsylvania
09353	C and K Components Watertown, Massachusetts
09423	Scientific Components, Inc Santa Barbara, California
09922	Burndy Corp. Norwalk, Connecticut
11236	CTS of Berne Berne, Indiana
11237	Chicago Telephone of Calif., Inc. (CTC) Paso Robles, California
11358	Discontinued
11403	Best Products Co Chicago, Illinois

11503 Keystone Mfg.
Div. of Avis Industrial Corp.
Warren, Michigan

11726 Quaddyne Corp.
Santa Clara, California

12014 Chicago Rivet & Machine Co.
Bellwood, Illinois

12040 National Semiconductor Corp.
Danburry, Connecticut

12060 Diodes, Inc.
Chatsworth, California

12136 Philadelphia Handle Co.
Camden, New Jersey

12323 Presin Co., Inc.
Shelton, Connecticut

12327 Freeway Washer & Stamping Co.
Cleveland, Ohio

12400 Replaced by 75042

12617 Hamlin Inc.
Lake Mills, Wisconsin

12697 Clarostat Mfg. Co.
Dover, New Hampshire

12749 James Electronics
Chicago, Illinois

12856 Micrometals
Sierra Madre, California

12954 Dickson Electronics Corp.
Scottsdale, Arizona

12969 Unitrode Corp.
Watertown, Massachusetts

13103 Thermalloy Co.
Dallas, Texas

13511 Amphenol Corp.
Los Gatos, California

13606 Sprague Electric Co.
Transistor Div
Concord, New Hampshire

13839 Replaced by 23732

14099 Semtech Corp.
Newbury Park, California

14193 California Resistor Corp.
Santa Monica, California

14298 American Components, Inc.
Conshohocken, Pennsylvania

14655 Cornell-Dubilier Electronics
Newark, New Jersey

14674 Discontinued, see 16299

14752 Electro Cube Inc.
San Gabriel, California

14869 Replaced by 96853

15636 Elec Trol Inc
Northridge, California

15801 Lenwal Electronics Inc
Framingham, Massachusetts

15818 Ameleo Semiconductor
Div. of Teledyne Inc
Mountain View, California

15849 USECO, Inc
Mt. Vernon, New York

15888 International Business
Machines (IBM)
Essex Junction, Vermont

15909 Replaced by 17870

16299 Corning Glass
Raleigh, North Carolina

16332 Replaced by 28478

16473 Cambridge Scientific Ind. Inc.
Cambridge, Maryland

16742 Paramount Plastics
Downey, California

16758 Delco Radio
Div. of General Motors
Kokomo, Indiana

17001 ITT Cannon
Santa Ana, California

17069 Circuit Structures Lab.
Upland, California

17856 Siliconix, Inc.
Sunnyvale, California

17870 Daven-Div of Thomas A. Edison
Ind. – McGraw - Edison Co.
Manchester, New Hampshire

18083 Deleted

18178 Vactec Inc.
Maryland Heights, Missouri

18612 Vishay Intertechnology
Inc.
Malvern, Pennsylvania

18736 Voltronics Corp.
Hanover, New Jersey

19429 Discontinued, use 89536

19451 Perrine Machinery & Supply Co.
Seattle, Washington

19701 Electra Mfg. Co.
Independence, Kansas

20584 Enochs Mfg. Co.
Indianapolis, Indiana

20891 Self-Organizing Systems,
Inc.
Dallas, Texas

22767 ITT Semiconductors
Div. of ITT
Palo Alto, California

23050 Product Comp. Corp
Mount Vernon, New York

23732 Tracor
Rockville, Maryland

23880 Stanford Applied Engrng.
Santa Clara, California

23936 Pamotor Div., Wm. J. Purdy Co
Burlingame, California

24248 Southco
Div. of South Chester Corp.
Lester, Pennsylvania

24655 General Radio Co.
West Concord, Massachusetts

24759 Lenox-Fugle Electronics
Plainfield, New Jersey

25403 Amperex Electronic Corp.
Semiconductor & Receiving
Tube Division
Slatersville, Rhode Island

27014 National
Semiconductor
Corp.
Santa Clara, California

[illegible] Molex Products
Downers Grove, Illinois

[illegible] Bohannon Industries
Fort Worth, Texas

28478 Deltrol Controls,
Corp.
Milwaukee, Wisconsin

28480 Hewlett Packard
Co.
Palo Alto, California

28520 Heyman Mfg. Co.
Kenilworth, New Jersey

29083 Monsanto, Co., Inc.
Santa Clara, California

30323 Illinois Tool
Works, Inc.
Chicago, Illinois

32539 Mura Corp.
Great Neck, New York

32767 Griffith Plastic
Products Co.
Burlingame, California

32879 Advanced Mechanical
Components
Northridge, California

32897 Erie Technological
Products, Incorporated
Frequency Control Div.
Carlisle, Pennsylvania

33173 General Electric
Co., Tube Dept.
Owensboro, Kentucky

34333 Silicon General
Westminster, California

34335 Advanced Micro
Devices,
Sunnyvale, California

37942 Mallory, P. R. & Co., Inc.
Indianapolis, Indiana

42498 National Company
Melrose, Massachusetts

43543 Nytronics Inc.
Transformer Co. Div.
Alpha, New Jersey

44655 Ohmite Mfg. Co.
Skokie, Illinois

49671 Radio Corp. of America
New York, New York

49956 Raytheon Company
Lexington, Maine

53021 Sanamo Electric Co.
Springfield, Illinois

55026 Simpson Electric Company
Chicago, Illinois

56289 Sprague Electric Co.
North Adams, Massachusetts

56474 Superior Electric Co.
Bristol, Connecticut

60399 Torrington Mfg. Co.
Torrington, Connecticut

62460 Deleted

63743 Ward-Leonard Electric Co
Mount Vernon, New York

64834 West Mfg. Co
San Francisco, California

[illegible] Weston Instruments Inc
Newark, New Jersey

66150 Winslow Tele-Tronics Inc.
Asbury Park, New Jersey

70563 Amperite Company
Union City, New Jersey

70903 Belden Mfg. Co.
Chicago, Illinois

71002 Birnbach Radio Co., Inc
New York, New York

71236 "I.T.M.I.N.C.O."
Willimantic, Connecticut

71400 Bussmann Mfg.
Div. of McGraw - Edison Co
Saint Louis, Missouri

71450 CTS Corp.
Elkhart, Indiana

[illegible] ITT Cannon Electric Inc.
Los Angeles, California

[illegible] Clare, C. P. & Co.
Chicago, Illinois

[illegible] Centralab
Div. of Globe Union Inc
Milwaukee, Wisconsin

71707 Coto Coil Co., Inc.
Providence, Rhode Island

71744 Chicago Miniature Lamp Works
Chicago, Illinois

71785 Cinch Mfg. Co. & Howard
B. Jones Div.
Chicago, Illinois

72005 Driver, Wilbur B., Co.
Newark, New Jersey

72092 Replaced by 06980

72136 Electro Motive Mfg. Co.
Willimantic, Connecticut

72259 Nytronics Inc.
Berkeley Heights, New Jersey

72354 Deleted

72619 Dialight Corp.
Brooklyn, New York

72653 G. C. Electronics
Rockford, Illinois

72665 Replaced by 90303

72794 Dzus Fastener Co., Inc
West Islip, New York

72928 Gudeman Co. (Gulton
Industries)
Chicago, Illinois

72982 Erie Tech. Products Inc
Erie, Pennsylvania

73138 Beckman Instruments Inc
Helipot Division
Fullerton, California

73293 Hughes Aircraft Co.
Electron Dynamics Div
Torrence, California

73445 Amperex Electronic Corp
Hicksville, New York

73559 Carling Electric Inc.
[illegible]

73582 Circle T Industries
Trenton, New Jersey

73734 Federal Screw Products Inc
Chicago, Illinois

73743 Fischer Special Mfg. Co.
Cincinnati, Ohio

73899 JFD Electronics Co.
Brooklyn, New York

73949 Guardian Electric Mfg. Co
Chicago, Illinois

74199 Quam Nichols Co.
Chicago, Illinois

74217 Radio Switch Corp.
Marlboro, New Jersey

74276 Signalite Inc.
Neptune, New Jersey

74306 Piezo Crystal Co.
Carlisle, Pennsylvania

74542 Hoyt Elect. Instr. Works
Penacook, New Hampshire

74970 Johnson, E. F., Co.
Waseca, Minnesota

75042 IRC Inc. (Div. of TRW)
Philadelphia, Pennsylvania

75376 Kurz-Kasch, Inc.
Dayton, Ohio

75382 Kulka Electric Corp.
Mount Vernon, New York

75915 Littlefuse Inc.
Des Plaines, Illinois

76854 Oak Mfg. Co.
Crystal Lake, Illinois

77342 Potter & Brumfield
Div. of Amer. Machine & Foundry
Princeton, Indiana

77969 Rubbercraft Corp. of Calif. LTD.
Torrance, California

78189 Shakeproof
Div. of Illinois Tool Works
Elgin, Illinois

78277 Sigma Instruments, Inc.
South Braintree, Massachusetts

78488 Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553 Tinnerman Products
Cleveland, Ohio

79136 Waldes Kohinoor Inc.
Long Island City, New York

79497 Western Rubber Company
Goshen, Indiana

79963 Zierick Mfg. Corp.
New Rochelle, New York

80031 Mepco
Div. of Sessions Clock Co.
Mornstown, New Jersey

80145 API Instruments Co.
Chesterland, Ohio

80183 Sprague Products
North Adams, Massachusetts

80294 Bourns Inc.
Riverside, California

80583 Hammarlund Co., Inc.
Mars Hill, North Carolina

80640 Stevens, Arnold Inc.
Boston, Massachusetts

81073 Grayhill Inc.
La Grange, Illinois

81590 Korry Mfg. Co.
Seattle, Washington

81312 Winchester Electronics
Div. of Litton Industries
Oakville, Connecticut

81439 Therm-O-Disc Inc.
Mansfield, Ohio

81483 International Rectifier Corp.
Los Angeles, California

81741 Chicago Lock Corp.
Chicago, Illinois

82305 Palmer Electronics
South Gate, California 90280

82389 Switchcraft Inc.
Chicago, Illinois

82415 Price Electric Corp.
Frederick, Maryland

82872 Roanwell Corp.
New York, New York

82877 Rotron Mfg. Co., Inc.
Woodstock, New York

82879 ITT Wire & Cable Div.
Pawtucket, Rhode Island

83003 Varo Inc.
Garland, Texas

83298 Bendix Corp.
Electric Power Division
Eatontown, New Jersey

83330 Smith, Herman H., Inc.
Brooklyn, New York

83478 Rubbercraft Corp. of America
New Haven, Connecticut

83594 Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740 Union Carbide Corp.
Consumer Products Div.
New York, New York

84171 Arco Electronics, Inc.
Great Neck, New York

84411 TRW
Ogallala, Nebraska

86577 Precision Metal Products
Stoneham, Massachusetts

86684 Radio Corp. of America
Electronic Components & Devices
Harrison, New Jersey

86689 Deleted

87034 Marco-Oak Inc.
Anaheim, California

88245 Litton Products Inc.
Van Nuys, California

88419 Use 14655

88690 Replaced by 04217

89536 Fluke, John Mfg. Co., Inc.
Seattle, Washington

89730 Replaced by 08806

90201 Mallory Capacitor Co.
Indianapolis, Indiana

90215 Best Stamp & Mfg. Co
Kansas City, Missouri

90211 Square D Co.
Chicago, Illinois

90303 Mallory Battery Co.
Tarrytown, New York

91293 Johanson Mfg. Co.
Boonton, New Jersey

91407 Replaced by 58474

91502 Associated Machine
Santa Clara, California

91506 Augat
Attleboro, Mass.

91637 Dale Electronics Inc.
Columbus, Nebraska

91662 Elco Corp.
Willow Grove, Pennsylvania

91737 Gremar Mfg Co., Inc. (ITT)
Woburn, Massachusetts

91802 Industrial Devices, Inc.
Edgewater, New Jersey

91836 King's Electronics
Tuckahoe, New York

91929 Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934 Miller Electric Co., Inc.
Pawtucket, Rhode Island

93332 Sylvania Electric Products
Semiconductor Products Div
Woburn, Massachusetts

94145 Replaced by 49956

94154 Tung-Sol
Div. of Wagner Electric Corp.
Newark, New Jersey

95146 Alco Electronics Products Inc.
Lawrence, Massachusetts

95263 Leecraft Mfg. Co.
Long Island City, New York

95264 Replaced by 98278

95275 Vitramon Inc.
Bridgeport, Connecticut

95303 Radio Corp. of America
Solid State & Receiving Tube Div.
Cincinnati, Ohio

95354 Methode Mfg. Corp.
Rolling Meadows, Illinois

95712 Dage Electric Co., Inc.
Franklin, Indiana

95987 Weckesser Co. Inc.
Chicago, Illinois

96733 San Fernando Electric Mfg. Co.
San Fernando, California

96853 Rustrak Instrument Co.
Manchester, New Hampshire

96881 Thomson Industries, Inc.
Manhasset, New York

97540 Master Mobile Mounts
Div. of Whitehall Electronics Corp.
Los Angeles, California

97913 Industrial Electronic Hdware Corp.
New York, New York

97945 White, S. S. Co.
Plastics Div.
New York, New York

97966 Replaced by 11358

98094 Replaced by 49956

98159 Rubber-Teck, Inc.
Gardena, California

98278 Microdot Inc.
Pasadena, California

98291 Sealectro Corp.
Conhex Div.
Mamaroneck, New York

98388 Accurate Rubber & Plastics
Culver City, California

98743 Replaced by 12749

98925 Deleted

99120 Plastic Capacitors, Inc.
Chicago, Illinois

99217 Southern Electronics Corp.
Burbank, California

99392 STM
Oakland, California

99515 Marshall Industries
Capacitor Div.
Monrovia, California

99779 Barnes Corp.
Lansdowne, Pennsylvania

Toyo Electronics
(R-Ohm Corp.)
Irvine, California 92664

National Connector
Minneapolis, Minn. 55436

Appendix B

List of Abbreviations

alternating current	ac
ampere	A
assembly	assy
binary coded decimal	bcd
bel	B
capacitor	cap
centimeter	cm
ceramic	cer
clockwise	cw
common-mode rejection ratio	cmrr
composition	comp
counterclockwise	ccw
decibel	dB
degree Celsius	°C
degree Fahrenheit	°F
digital voltmeter	dvm
direct current	dc
electrolytic	elect
external	ext
farad	F
field effect transistor	FET
germanium	Ge
giga (10^9)	G
gigahertz	GHz
ground	gnd
guard	gd
henry	H
hertz	Hz
high frequency	hg
hour	h
inch	in
integrated circuit	IC
intermediate frequency	if
internal	intl
kilo (10^3)	k
kilohertz	kHz
kilohm	kΩ
kilovolt	kV
low frequency	lf
maximum	max
mega (10^6)	M
megahertz	MHz
megohm	MΩ
meter	m
micro (10^{-6})	μ
microsecond	μs
milli (10^{-3})	m
milliamperes	mA
millimeter	mm
millisecond	ms
millivolt	mV
minimum	min
nano (10^{-9})	n
nanosecond	ns
negative	neg
ohm	Ω
oscilloscope	scope
parts per million	ppm
peak-to-peak	p-p
pico (10^{-12})	p
picofarad	pF
plus or minus	±
positive	pos
plastic	plstc
printed circuit board	pcb
radio frequency	rf
root mean square	rms
second (time)	s
serial number	SN
silicon	Si
tantalum	Ta
temperature coefficient	TC
tera (10^{12})	T
transformer	xfmr
transistor	xstr
ultra high frequency	uhf
variable	var
very high frequency	vhf
very low frequency	vlf
volt	V
voltage controlled oscillator	vco
watt	W
wirewound	ww

Appendix C

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Zip 35801

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Tel. (206) 762-2310
Zip 98108

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Tel. (602) 947-7841
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940 N. Fern Creek Ave.
Tel. (305) 896-4881
(305) 843-1510
Zip 32803

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DECATUR
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2522 Tanglewood Road
Tel. (404) 321-0980
Zip 30033

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646 Queen Street
P.O. Box 135
Tel. (808) 533-6095
Zip 96817

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1301 N. Rand Road
Des Plaines, IL 60016
Tel. (312) 298-3600

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Port O'Call Executive Ctr.
21 Beachway Drive
Tel. (317) 244-2456
Zip 46244

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Tel. (502) 935-9634
Zip 40272

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Kensington, MD 20795
Tel. (301) 881-5300, 744-7700

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Lexington, MA 02173
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Zip 87112

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Tel. (914) 769-1811

ROCHESTER
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Tel. (716) 226-1400
Zip 14622

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P.O. Box 9619
1310 Beaman Place
Tel. (919) 273-1918
Zip 27408

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16141 Puritas Ave.
Tel. (216) 267-0445
Zip 44135

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6073 Far Hills Ave.
Tel. (513) 434-7500
Zip 45459

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Tel. (503) 646-3004
Zip 97005

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King of Prussia, PA
Tel. (215) 248-5050
Zip 19406

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Tel. (412) 892-2953
Zip 15236

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DALLAS
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908 Business Parkway
Richardson, TX 75080
Tel. (214) 231-2573

HOUSTON
Barnhill Associates
10606 Hempstead Hwy.
Suite 132
Tel. (713) 688-9971
Zip 77018

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BCS Associates
107 Rich Neck Road
Tel. (703) 229-5108
Zip 23185

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Showalter-Judd, Inc.
5616 4th Ave. South
Tel. (206) 762-2310
Zip 98108

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02700 Kauniainen
Finland

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8 Muenchen 19

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New Zealand

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NORWAY
Morgenstierne & Co. A/S
P.O. Box 6688 Rodeløkka
Oslo 5, Norway

PAKISTAN
Pak International Operations
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P.O. Box 5323
Karachi, Pakistan

PERU
Importaciones y Representaciones
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Equipamentos De Laboratorio, Ldâ.
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SWEDEN
Teleinstrument AB
P.O. Box 490
S-16204 Vallingby, Sweden

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Bernerstrasse Sud 169
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Suriwong
Bangkok, Thailand

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